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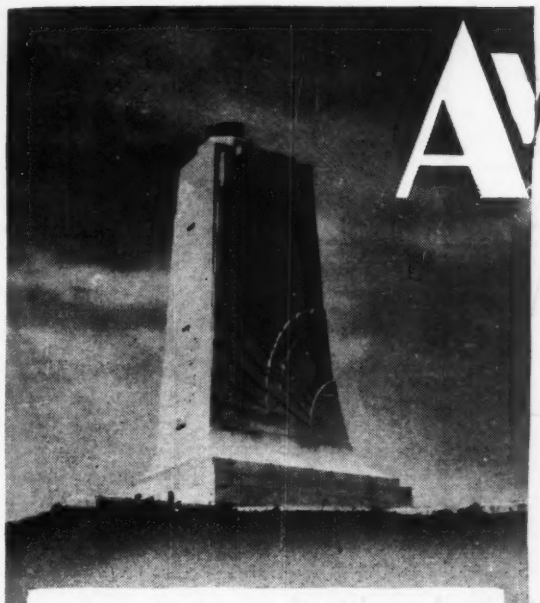

AVIATION

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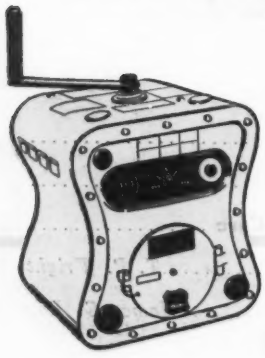
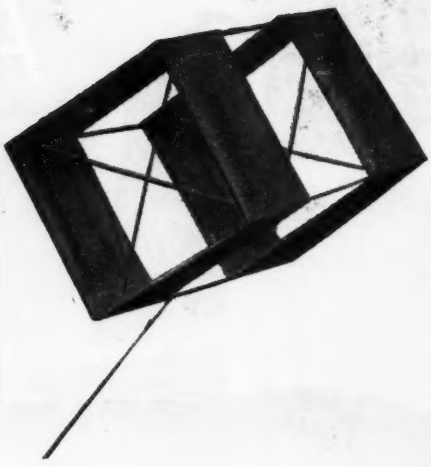
THEIR FAVORITE BLONDE





THIS IS THE GIBSON GIRL* with her hourglass shape and a bright yellow dress . . . the magic emergency radio transmitter which automatically sends out S-O-S signals by merely turning the hand crank. ☆ Now carried on overwater flights by most military planes, Gibson Girls have snatched back to life many American, Canadian and British crews forced down at sea. ☆ The hand crank generates sufficient power to transmit signals over a 100,000 square mile area, and to light a brilliant signal light. Manual keying on radio transmission is available. The unit is equipped with parachute for release from a rescue plane or before a crash landing. ☆ More than 60,000 Gibson Girls have been produced by Pacific Division since they were developed by this company before Pearl Harbor. Such outstanding radio developments as this demonstrate Pacific Division's unique ability to successfully solve new radio problems. Our engineers—now specializing in VHF communications systems—are available to assist you with your radio problems.

*Trade Mark Reg. U.S. Pat. Off.

All rescued airmen become members of the most exclusive fraternity in the world—the Order of Gibson Girls. They receive this certificate and a gold lapel pin. If you have been rescued or know someone who has, write today to the Order of Gibson Girls, North Hollywood, California, for membership.

Pacific Division
Bendix Aviation Corporation
NORTH HOLLYWOOD 7, CALIF.

BRIEFING

Last month we shot the works talking about Ralph Upson's series and, normally, wouldn't be leading off about it again. But as we present the second article of the series we'd like to double it all in spades, for he has really done a job. This month (beginning on page 145) he comes through with what amounts to preliminary design on no less than five possible personal plane types, comparing the advantages and disadvantages of each. The engineering data going with this installment will serve as real A-1 reference material.

Again we're proud to present one of AVIATION's inimitable Design Analyses,—we say proud because we've been told they're jobs that haven't been touched in the aeronautical publishing field. This time it's Consolidated Vultee's famed B-24 Liberator, written in complete detail by J. H. Famme, Chief Design Engineer at Convair's San Diego Division where the Lib was born. Turn to page 121.

A lot has been said about sonic speed, but there is still much more to be done about it. With the opening of the Southern California Cooperative Wind Tunnel, though, that picture should be changing soon, for this new tunnel is designed for research at better than 700 mph. Just what the tunnel is and how it works is told by its Director, Dr. Clark B. Millikan, in the complete article beginning on page 155.

Plenty of new airplanes this month—six military types and two brand new commercial jobs. Military group includes: The Avro Lincoln (page 164), first British bomber in the Superfortress weight class. Included is our staff artist's sketch of this latest mammoth warcraft to go into production. . . . First photos and data on Grumman's new F7F Tigercat (page 170), a twin-engine fighter which the Japs are *not* going to like . . . And first published sketches and specifications on four new Nip warplanes—George and Frank 1, fighters; Judy 33, carrier-based dive bomber, and Peggy 1, an army recon-bomber (pages 171 and 172). Commercial models featured are: The Aero Commander (page 163), a twin-engine, five-six-place craft designed on the West Coast . . . And de Havilland's Dove (page 169), proposed eight to eleven passenger craft greatly resembling Britain's justly famed Mosquito bomber.

ROY HEALY, vice-president of the American Rocket Society, is shown here with rocket-firing North American P-51 somewhere in Burma, where he was assigned as technical observer when this new type weapon first went into action in that theater. In the first of a two-part series, beginning on page 152, Mr. Healy forecasts some mighty startling possibilities for rockets—in peacetime as well as wartime uses.

We have two feature stories in the Marketing section this month. Our initial article injects some brand new thoughts into the postwar personal plane market potentials. Here, for the first time, utility has been defined and rated so that, by using the method described, each manufacturer or distributor can reach his own estimates of what market he thinks he can corner for himself. Turn to page 113.

The second feature clarifies the misunderstanding which has grown up around the disposal of surplus aircraft and, more important, shows how money has been made and can still be made in this field. See page 118.

Down the Years in AVIATION'S Log

25 Yr. Ago (1920)—Air Mail service reports 85 percent trips completed in past year. . . . War Dept. designates eight airfields for reserve officers' flight practice. . . . Goodyear's Pony Blimp passes tests. . . . Packard builds 600-hp. V-12 engine weighing less than 2 lb. per hp. . . . Farman Goliath, piloted by Bossoutrot and Bernard, breaks endurance record with 24 hr. 19 min. flight.

15 Yr. Ago (1930) — Radio first used in solo flight instruction. . . . Kingsford-Smith flies Fokker F-7 in first westward trans-Atlantic flight, his speed averaging 70 mph. . . . Roger Williams flies non-stop, New York City to Bermuda and return, in 17 hr. in Bellanca "Columbia". . . . Amelia Earhart, flying Lockheed Vega, breaks women's speed record at 174.9 mph. . . . Detroit Aircraft's Gull gets first glider certificate. . . . Stanley Huffman of Cincinnati flies Aeronca for 25 hr. 42 min. . . . PAA starts 1,800-mi. mail service along east coast of South America. . . . Union Oil of Calif. subsidizes glider instruction for employes.

10 Yr. Ago (1935)—Alaska Transport formed at Juneau. . . . Dept. of Commerce plans to spend $2,000,000 on airfields for Alaska. . . . Bowles airport at Springfield, Mass. is taken over by horse racing syndicate. . . . Washington Aircraft Corp. of Seattle issues fuel-credit cards to cross-country pilots. . . . PAA Clipper makes first flight to Midway. . . . Kellett Autogiro lands mail on Philadelphia Post Office roof.

Sign of the Times

So you're going to operate an air taxi! Well, it may not be long, now . . . you'll put the finishing touches on the sign over the office door, insert your first ad in the daily paper, and take up a strategic position by the telephone to greet your first customer.

But in planning and working for this big moment, you will have faced three paramount requirements of successful operation: safety in flight operation and navigation, economy of operation, and ability to render around-the-clock, around-the-calendar service to the public.

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EDITORIAL

Cutbacks Must Be Handled With Care

WITH MILITARY VICTORY in Europe less than two months old there are disquieting signs of divergent views among the victors and many unsolved political problems in many places in the world. Those who expected a miracle to rise up out of the mist of San Francisco Bay are destined for disappointment. Those who are more realistic in their appraisal of world peace efforts know that there are years of disheartening work ahead before the complete structure of a security organization can be built and made to function.

In spite of all these cold facts a substantial segment of the American people has written off the war and settled down to personal postwar planning. Even in Congress legislation important to our future security has been sidetracked or is being shelved at a time when we as a nation are becoming much less warlike each succeeding day.

We are still awaiting the initial steps in the formulation of basic long term airpower policies. And our capacity to build aircraft has already begun to be cut back.

WE CANNOT EXPECT to maintain our aviation industry at wartime levels indefinitely, but we must not be too eager to cut it back. There is less to be feared from orderly deflation than there is from the possibility of unwillingness of the American people to maintain our dominant airpower. As long as the industry is not permitted to shrink below the point where it can develop a continuous procession of new and better design; as long as it preserves a sound nucleus capable of quick emergency expansion, we need have no fears for the future.

But a minimum point must be determined and no degree of complacency must be permitted to influence us to go below it. In no other major nation in the world is aviation technology being permitted to lag, and we dare not arrest scientific progress by impairing our efforts in that direction.

IN HIS BRILLIANT Wilbur Wright Memorial Lecture, excerpted on page 106, Civil Aeronautics Administrator T. P. Wright has made some predictions, in terms of employment, of the size to which the whole aviation industry may be expected to shrink 8–12 years after the war. If these estimates are possessed of the same uncanny accuracy as those he made for the expansion of the manufacturing industry, we may rely on them as completely as did hundreds of manufacturers planning their expansion.

Mr. Wright envisions a total personnel level of more than 600,000, including manufacturing, operations and government agencies. This estimated figure represents a substantial shrinkage from the war time peak but is about twelve times the prewar level. Of this total some 335,000 employees are expected to constitute the personnel of the manufacturing industry, but only 210,000 will be engaged in military aircraft manufacturing. Whether this number will provide an industry sufficiently large for our national security is a question deserving urgent consideration.

Mr. Wright probably bases his estimates on the assumption that in 8–12 years we will have reached a period in which the nations of the world have learned to settle their disputes by diplomatic means. This is a condition for which all of us most fervently hope. But it is the interim period which we are just about to enter that will be the critical time in world history.

The prospects that the United States can influence the world toward peaceful ways will be much brighter while we possess the world's largest air force and the productive capacity to keep it in the dominant position. If we permit our airpower to weaken—and with it our technological leadership—the hope for world peace will fade with great rapidity.

Leslie E. Neville

EDITOR

AVIATION'S PLACE IN CIVILIZATION

Properly used, the airplane can be a tremendous force for world peace, as is shown by forecasts of air transport and personal flying developments . . . Excerpts from the 33rd Wilbur Wright Memorial Lecture presented before the Royal Aeronautical Society by—

By T. P. WRIGHT, *Civil Aeronautics Administrator*

LET US FIRST DEFINE the terms of our subject. Aviation, of course, is the art of flying. Civilization is a condition of human communities, characterized by political and social organization and order; advancement in knowledge, refinement and the arts; and continuous progress in the realization of social, cultural and religious values. The problem which we must see and really appreciate exists is, therefore: can we so manage aviation that it will contribute to the development of civilization?

In World War II air power has taken a position of equal importance with other service arms. In some respects the importance is greater, although any attempt to appraise relative roles of the air, land and sea arms is misleading, as it has been proved time and time again that their coordinated use is in most instances essential.

We must stress the tendency of modern war towards total destruction—a truly vicious spiral insofar as progress of civilization is concerned; and again we must appraise our ability to master ourselves in using the types of weapons which we now have available. Locating our factories underground and possibly moving many more activities similarly can only be looked upon as a retrogression and probably an ineffective measure. In this regard, although dealt with later more extensively, I would like to introduce here the conception of the tremendous difference between war and policing; the one for destruction to attain national ends, the other to maintain order and achieve security for all.

It is appropriate to stress the fact that warfare has changed from a conflict between the armed forces to total war which encompasses whole populations both as targets and as producers

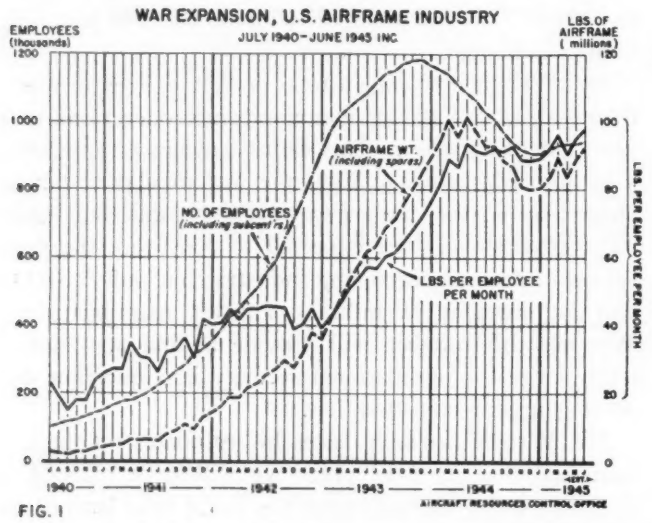
WAR EXPANSION, U.S. AIRFRAME INDUSTRY
JULY 1940 - JUNE 1945 INC.
EMPLOYEES (thousands)
LBS. OF AIRFRAME (millions)
LBS. PER EMPLOYEE PER MONTH
AIRFRAME WT. (including spares)
NO. OF EMPLOYEES (including subcontr'rs)
LBS. PER EMPLOYEE PER MONTH
1940 1941 1942 1943 1944 1945
AIRCRAFT RESOURCES CONTROL OFFICE

FIG. 1

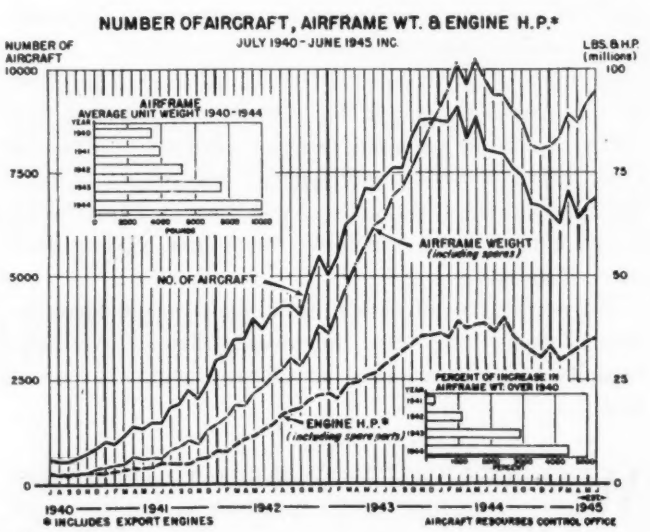
NUMBER OF AIRCRAFT, AIRFRAME WT. & ENGINE H.P.*
JULY 1940 - JUNE 1945 INC.
NUMBER OF AIRCRAFT
LBS. & H.P. (millions)
AIRFRAME AVERAGE UNIT WEIGHT 1940-1944
AIRFRAME WEIGHT (including spares)
NO. OF AIRCRAFT
PERCENT OF INCREASE IN AIRFRAME WT. OVER 1940
ENGINE H.P.* (including spare parts)
1940 1941 1942 1943 1944 1945
* INCLUDES EXPORT ENGINES
AIRCRAFT RESOURCES CONTROL OFFICE

FIG. 2

United States Employment—Derived from Aviation
A Forecast—8-12 Years After the War

Manufacturing—(*1)		
Personal Aircraft	100,000	
Transport Aircraft	25,000	
Total		125,000
Military		210,000
Total Manufacturing		335,000
Air Transportation—(*2)		
Scheduled (Domestic)	115,000	
Scheduled (International)	30,000	
Nonscheduled	30,000	
Total		175,000
Service Industry		80,000
Government		20,000
Total Air Transportation		275,000
Grand Total—(*3)		610,000 (*4)

*1—Includes "Grass Roots" Employment at 33% of Total.
*2—Includes "Grass Roots" Employment at 20% of Total.
*3—The Money Value of the Products and Services Given Are Just Under Three Billion Dollars.
*4—Prewar Employment was 50,000; War-Time Peak, Excluding Uniformed Personnel, 2,750,000.

Fig. 3

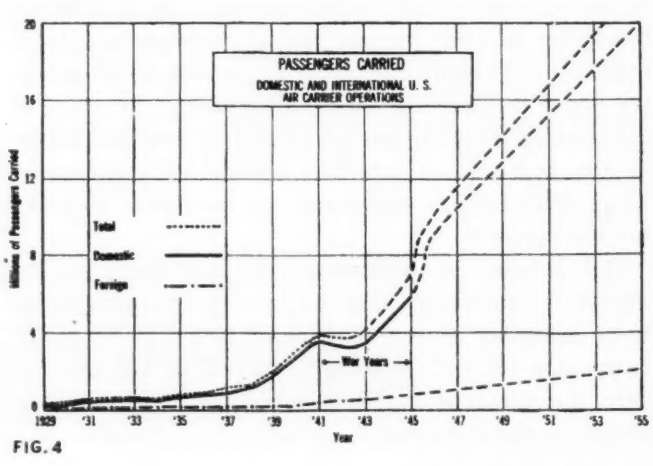

FIG. 4

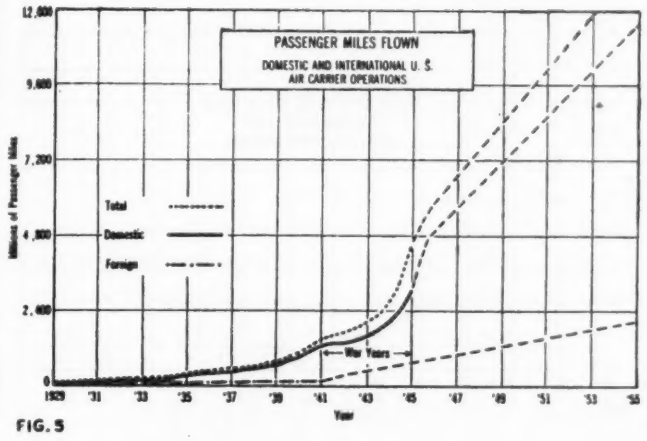

FIG. 5

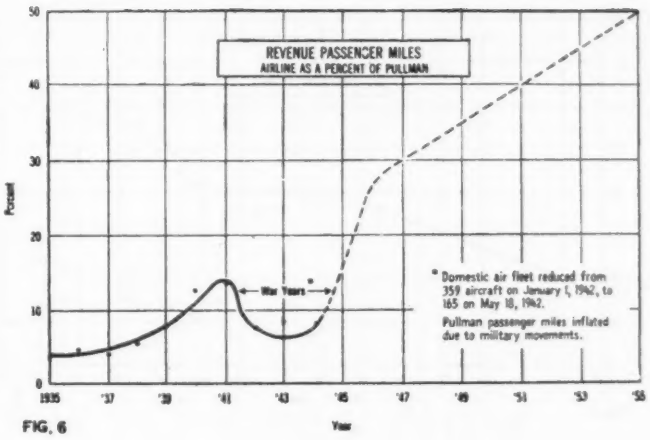
REVENUE PASSENGER MILES
AIRLINE AS A PERCENT OF PULLMAN
War Years
* Domestic air fleet reduced from 359 aircraft on January 1, 1942, to 165 on May 18, 1942.
Pullman passenger miles inflated due to military movements.
Year

FIG. 6

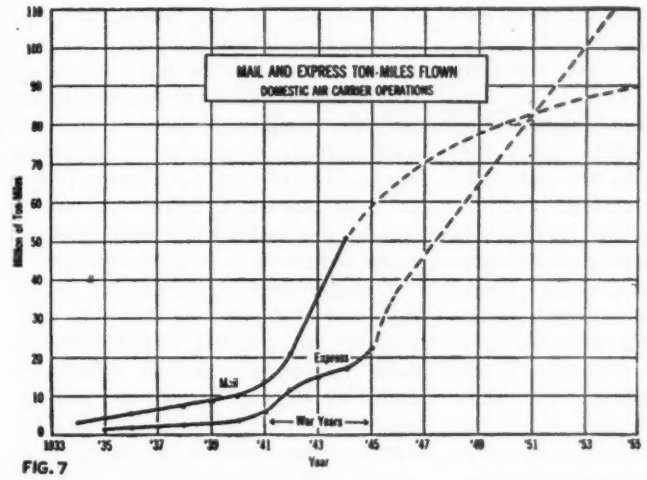

FIG. 7

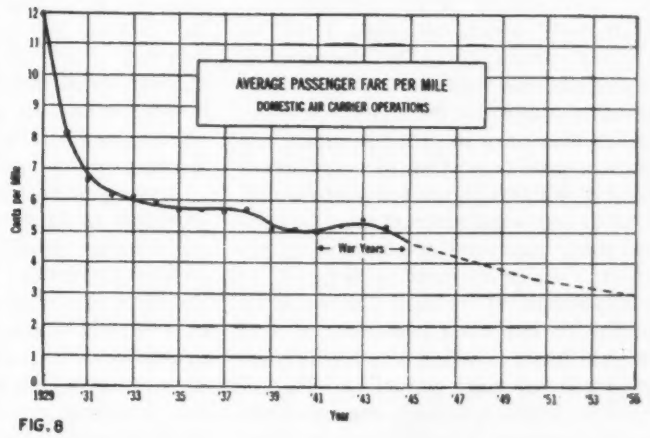

FIG. 8

of weapons. Possibly this can be best illustrated by indicating the extent of our aircraft production program in the United States. For this purpose, there are shown two curves, Fig. 1 indicating graphically the output from July, 1940, to the present time in terms of airframe weight, airframe employees, and resultant efficiency, as pounds per employee per month.

On Fig. 2 is shown the climb in output during the same period repeating the airframe weight curve and adding the story on engine horsepower and number of airplanes. The magnitude of the effort is also depicted in terms of increase in airframe weight. Compared to July, 1940, production, the war period shows a 4,500 percent increase. The 3-fold increase in the average size of aircraft during the period is of interest. In round numbers, the annual aircraft deliveries in the U. S. starting with 1940 were 6,000; 19,000; 48,000; 86,000 and finally in 1944, 96,000. But because of this increase in average size, the yearly output in terms of airframe weight increased from 21 million lb. in 1940 to 1.1 billion in 1944—over 50-fold.

Let us appraise this increase and its present status in terms of overall national economy. Here we find that the manufacture of aircraft (completely applied to the waging of war) has, in the United States, attained a relation, when compared to total munitions output, of 27 percent; to total manufacturing output of all kinds, of 20 percent; to total national income, of 10 percent. These facts, considered in conjunction with the deficiencies in manpower present in all countries and the very high percentage of female employees in war factories, stress the total character of modern warfare. Even in peace times upward trend of costs for military preparation could but be viewed with alarm. In the Axis states in the 1930's it approximated 25 percent of national income.

It should be noted that, with the exception of the specific military character of some of its cargoes, all uses developed during the war for the air transport plane will have direct application to peacetime functions.

At the present time very great effort is being made by the CAA to lay a proper foundation for a rapid but sound development of private flying, the importance of which can scarcely be overestimated. The encouragement to the owner of the personal aircraft furnished by CAA is incorporated in four-plank program:

First is the establishment of airports, particularly those of the smaller sizes adapted for use of the private flyer. At present the airports in the United States total about 3,000. The federal aid airport program which we have suggested to the Congress for consideration envisages an increase to 6,000. Over 80 percent of the increase will be in the smaller Class I and II airports. The program is so planned as to place airports at relatively uniform distances and in sufficient numbers in communities as to make private flying really practicable, as is the case with the automobile driver who has surfaced roads available for his use.

The second point is to examine existing regulations and their effect on private flying, with view to making recommendations to the Board covering changes which will, to the maximum extent possible commensurate with public safety, relax requirements and make it easier to obtain a pilot certificate and otherwise enhance the attractiveness of personal aircraft ownership and operation.

The third point is the encouragement of aeronautical education and pilot training. It is hoped again to establish a federal aid pilot training program which, in company with the high school educational work that is being established, will make the coming generation universally air minded.

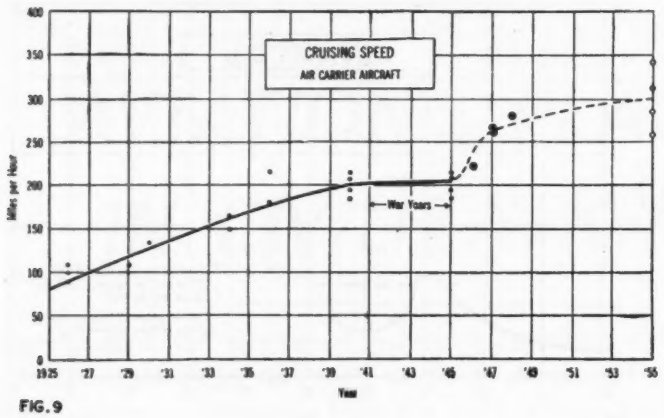

FIG. 9

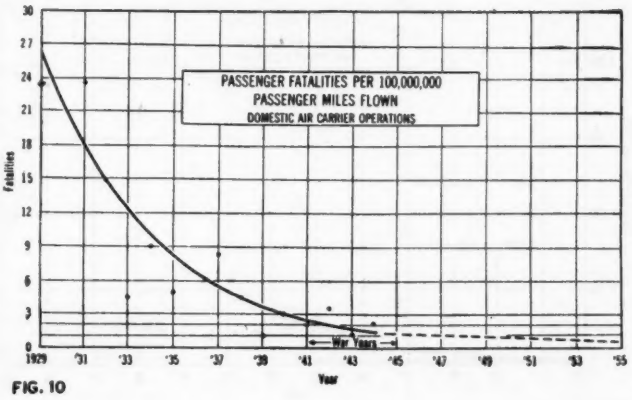

FIG. 10

The final plank in the program is the development of the personal aircraft itself, which, although it will be carried out in detail by the aircraft manufacturing industry, will be fostered and aided by the CAA. It is believed necessary in order to attain our present goal consisting of a registered total of 400,000 planes ten years hence, that the personal aircraft must be considerably improved in a number of respects. Its price must be reduced, its safety enhanced, its utility increased by means of improved performance, and several features added which will make it in general more attractive. Here I refer particularly to such improvements as the decrease in noise, making flying more pleasant not only for the occupants of the plane, but for the residents living adjacent to the airparks, which, under our airport program, must, we feel, be located within residential sections if they are to serve their proper purpose. Another feature in the development of the airplane itself is the further development of the undercarriage, possibly along the lines of the Maclaren gear developed in England, which will make crosswind landings safe and practicable.

It is the hope of those of us involved in carrying through this program that we may contribute towards meeting the overshadowing need of our generation for intelligently organizing government operation dedicated to the advancement of the common good—in this case, aviation. In this highly specialized age it is particularly necessary that government cooperation be extended in such fields, as the average man cannot possibly keep abreast of the rapidity of technical advances.

Another point to note is the cooperative nature of development, contributions coming from many people in many nations. This was amply evident to me during my trips to England during the war, when a slightly different point of view which had gained ascendancy in your country led to long trains of fruitful speculation on developments which we were considering or had undertaken.

It is important that we use this vast reservoir of knowledge acquired during the war for advancing the general welfare thereafter. Through intensification of research and implementation of technical education, and with the groundwork in technical development in aviation which we now inherit, we are, I believe, on the threshold of the greatest period of aeronautical development that has yet been witnessed.

To mention but a few items which may revolutionize development I would cite: the gas turbine and jet power plant, which will increase in efficiency as aircraft speeds go up, thus making aerodynamic development a limiting factor in speeds to be attained as distinguished from the power plant limitations (including the propeller) already reached at speeds of 475 mph., laminar flow wings; the development of structural designs suitable for such wing shapes, especially in thin sections, necessary to surmount our next barrier—compressibility.

Our greatest effort from the research standpoint in the next period of time will be the investigation of aerodynamic phenomena at supersonic speeds. Possibly we have far to go before transcending the speed of sound, but the rapidity of present development indicates that this may be accomplished in the not too distant future. It is of interest to note that, having passed the speed of sound, there is some reduction in drag coefficient.

Developments of comparable magnitude and of equal importance to aviation are to be found in the electronic field. Electronic devices which will make all-weather operations safe and practicable are already in the offing and further developments, probably using radar, will make air traffic control a matter of individual separation as on the roads rather than by ground instruction and control. Each pilot will do his own flying, so to speak, his own instrument weather navigating, determining from his instrument board "screen" his proximity to others.

Then there is the helicopter, (only just getting itself off the front pages of popular magazines), which will experience an intensive development which bids fair to make it a popular private plane of the future. It will supplement the air transport plane as the automobile does the railroad. There are, of course, possibilities of combinations of rotating and fixed-wing aircraft, which may achieve both low landing speed and high cruising speed, not apparently attainable by the helicopter itself.

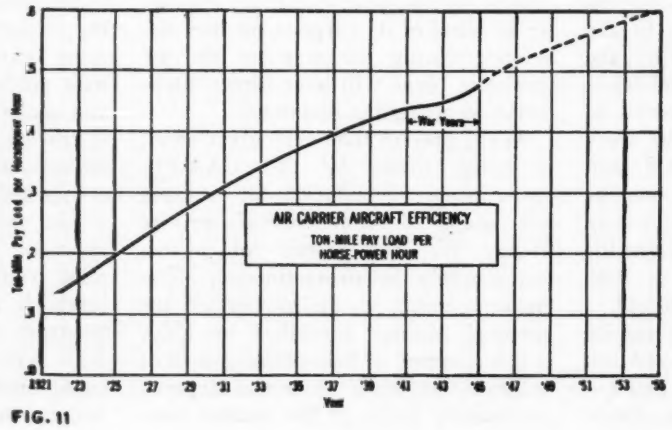

FIG. 11

Accompanying these technical developments is the need for simplifying operation of the aircraft and reducing costs, particularly in the private-owner field, so as to make possible the tremendous expansion there which many envisage.

Again I express it as my considered belief that

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Concluding a most important series, this veteran industry leader shows that adequate air transportation, postwar employment, and national security factors all contribute to one urgent demand —

Let's Have Feeder Airlines Now

PART IV OF A SERIES

By JAMES G. RAY, *Vice-President, Southwest Airways Co.*

A FACTUAL APPROACH to the problems of feeder airline service has been the aim in our preceding three articles. Traffic projections for feeder towns, for example, were based on the actual traffic generated by towns of similar size and location having air service in 1940. The results of this method of study must be interpreted in relation to other basic considerations. A more philosophic approach is necessary to see the whole problem in its true light.

The sample towns did not have feeder airline service—they only were afforded the local air service that a trunk line can furnish as a by-product of its through service. And there is a great difference. The schedules were generally infrequent and the service at inconvenient hours. That a seat would be available was uncertain. Flights were often delayed, possibly by adverse flight conditions a half-continent away.

Such service is a poor measuring stick by which to judge the patronage that can be expected of a feeder service laid out to meet the specific travel needs of the people who live in the smaller cities and towns.

CAB member Josh Lee has pointed out the inadequacy of this approach by saying: "I cannot agree with those who continue to insist that there will be no phenomenal increase in aviation after the war. They take a certain percent of the passengers who, before the war, crossed the Atlantic by steamer, first-class, and a small percent of those who traveled steerage—add them together, project them, and say, 'this is the maximum number of passengers who can be expected to cross the Atlantic after the war.' It would have been just as logical to have determined how many people crossed the American desert by stage coach, projected that figure, and then announced, 'this is the minimum number of passengers who may be expected to cross the United States by rail.'"

Also, Martin Taitel, a research analyst for the CAA has pointed up the ultra conservative market surveys made in the early days of the automobile by people who tried to project its utility by analyzing the actual use then being made of the buggy and carriage. Some of their estimates of the number of automobiles that could be sold annually were considered fantastic at the time—but proved to be a very small percent of the actual volume of manufacture a few decades later.

Many journeys not made at all now would be made if suitable transportation were available, but the volume of this extra traffic only can be "guesstimated". We can imagine that Farmer Brown who has a chicken ranch at Concordia, Kan. would attend a poultrymen's association luncheon in Kansas City if that 200-mi. trip could be made without interfering with the daily chores around the ranch. Mrs. Brown would come in more often to do her shopping, and Junior could be

taken to see that Kansas City specialist about his ear trouble.

All studies of transportation indicate the large amount of travel between the satellite towns and their trade area center. This type of traffic can be tapped only by a local air service laid out to fill the needs of the residents of the satellite communities. To estimate the volume of this feeder airline traffic by using long-haul traffic records is obviously too conservative. Thus the profits to the government from establishing a system of feeder airlines would be much greater than the amount shown in the previous articles.

It has not been possible to combine local and long-haul transportation in any other means of transport. We wouldn't expect the *Queen Mary* to be used to bring passengers across the Atlantic and then to deliver them to the dozen or more cities along our Eastern Seaboard. Nor would the Twentieth Century Limited or the

Super Chief be used to carry local or commutation traffic between the larger cities and their suburban towns.

In the air, too, different types of traffic will be carried in different vehicles. It just doesn't work to land transcontinental planes at Concordia. The schedules are set for the convenience of larger cities farther away and would not fit the local needs. Nor would they be reliable or dependable enough for local use, because any delay occurring anywhere along the transcontinental route might cause Farmer Brown to miss his luncheon engagement.

But, so far there has been no separation of local and long-haul traffic in air transport. The only available type of service has been long-haul.

Thus it becomes apparent that feeder service is to be a separate operation from long-haul or trunk line service. Different equipment, traffic, and operating procedures will require a different operating organization from top to bottom.

In the other forms of transport, except rail, the separation is so complete that there is little if any economy in having both operations conducted by the same operating company. In the case of the railroads, the two types of equipment used for the two kinds of traffic must use the same tracks. But this reason for having one company furnish both kinds of service does not apply in air transportation.

It is obviously quite possible to have the same management own and control the two separate operating organizations. An organization making fine watches and one manufacturing concrete mixing equipment could be under the same management, too. But it would be an unusual group of men who could understand the management problems of both businesses. As a general rule, the efficiency of management deteriorates when its efforts are divided between unrelated activities.

The difference between carrying long-haul and short-haul air traffic is not as great, of course, as that between the manufacture of watches and concrete mixers. But there is still a very substantial difference. To begin with, different and specially designed aircraft will be required for feeder operation. It follows that there will be a need for a separate staff of pilots who are expert on operating this aircraft and who are thoroughly familiar with the flight procedures necessary. These different operating procedures will require separate dispatching and flight control personnel.

It also follows that maintenance and overhaul will be different, with different personnel, separate tools and shops, and different spare parts and equipment. Even the traffic departments would need different people to solicit the two kinds of traffic. The printed literature, posters and advertising would be separate because it would be amed at a different market.

A trunk line could, it must be stated, establish a separate division to operate feeder service. This separation could extend on into management, and conceivably a good operating job could be done for each type of service. But the arrangement would not result in greater economy—chances are that the feeder operation would be neglected, that it would become a stepchild, so to speak, while the long-haul operation would rate more prestige and management attention. Thus the more capable personnel would be drawn away from the feeder operation and it would be left with inferior direction.

But there are a number of other reasons why it is in the public interest to have the feeder network operated by independent operators. Probably the most valid of these is the attitude of the trunk airlines toward feeder service, as expressed by their managing officers. By and large they are just not interested.

As would be expected, policies vary with different companies, but though great efforts are being made by all the organizations to expand their long-haul services, only a very few of the smaller ones are willing to provide feeder service. To put over something new requires, first, an open mind and, second, a belief in the project. From public statements and from the positions taken in the recent CAB regional hearings, it is obvious that, with few exceptions, the trunk airline managements have neither.

It is an accepted economic principle that a new type of business can best be promoted and developed by an organization whose primary purpose is the operation of that business. Development of feeder airlines is in itself a big job and will require the full-time attention of its management. Certainly development of such lines is too big a job for a part-time management that has repeatedly shown a lack of interest.

Another important reason for independent feeder line operation is the problem of controlling competition between the two or more trunkline operators presently serving each of the larger trade centers which form the logical hubs of feeder systems. In the interest of economical operation, it will be desirable to have all feeder routes radiating from any one center, such as Chicago or Atlanta, operated

by the same feeder operator. The economy of size cannot be realized otherwise. If any of the trunk lines serving a trade center should be franchised for the feeder operation, it is logical to expect competitive practices that might not be in the public interest.

Traffic generated on the feeder routes would arrive at the center already ticketed for more distant common points of service over the operator's own trunk lines, regardless of whether the schedules were the most convenient or whether the services were more acceptable. By adjusting its own feeder and trunk line schedules, it could be made very difficult for passengers to use competing services.

Thus the feeder operation would become a weapon of competition and a means of generating long-haul traffic. An operation designed to accomplish this purpose would fail to serve the real needs for local and short-haul transportation. Only an independent operator could be expected to approach this problem from the standpoint of public need.

In the bitter fights for new routes now raging between the existing air carriers, the urgency of protecting the sources of their traffic is revealed. Frequently, smaller towns already having air service are applied for, not because the towns need extra service, but because the new applicant wants to get a share of the long-haul traffic originating from them.

If trunk lines were to operate feeder services, this practice would continue, possibly until each carrier operating into a trade area center also would run a feeder service to each satellite community. Such a pattern would, it is felt, be very uneconomical, but would be a logical result of each carrier's efforts to protect its long-haul traffic at the source.

An independent operator would be free to fully develop the local and short-haul traffic by rendering the maximum amount of efficient service to the public. His schedules would connect impartially with trunk line schedules to provide the greatest convenience to his passengers.

Actually some trunk airlines have maneuvered themselves into a very odd position as to their feeder airline policies. They realize that it isn't very practical for them to go after local traffic. Too, their energies and resources presently are being absorbed in plans for the expansion of long-haul operations. But they don't want new operators in the air transport field; so they have taken the position that the nearly one-third of our population living in the smaller cities and towns should not have air transportation.

Usually in considering the need for feeder service a study is made of the travel requirements of the small towns to which service is being extended. Actually this is only half the story. The people living in the larger cities already receiving direct air service are being given an expanded and a more valuable service, too. It has often been pointed out that feeder lines would bring direct air service to nearly an additional one-third of our population. The third that is already receiving direct air service could go to a much larger number of places by air and consequently would be greatly benefited by feeder service.

The greatest justification for a national system of feeder lines is their usefulness as transportation. They can supply a service affording greater speed and convenience than any other media of transport. But there are other national benefits that would result from establishing such a system at this time.

A national air feeder system furnishing service to most of the towns large enough to support it would provide employment for a goodly number of our returning veterans—nearly as many as can be employed by the trunk airlines.

From our experiences during the early '30's we know how terribly expensive unemployment can be to the nation. Our reconversion and re-employment process after the war will be

difficult at best. Here is a way to provide industry-supported jobs at little or no government expense. National planning should take advantage of every opportunity to create additional self-supporting jobs as a means of avoiding the dole and WPA type of relief. The amount of re-employment that feeder airlines can give is great enough to assume national importance.

This is doubly true because of the kind of jobs that would be provided. Our national defense will require that all phases of our aviation industry—developmental, production, and operational—be maintained at a high level.

The public knows how small a reservoir of aviation technicians this country had at the time of Pearl Harbor. This shortage cost us billions of dollars. The greatest lesson we can learn from this war is the appalling cost of not keeping our weapons ready. Our greatest weapon is our aviation know-how.

Because of its strategic importance, our aviation industry must be maintained, even if it does not appear to be self-supporting. No bets should be overlooked that will help to make it so. Feeder airlines, of course, would employ many pilots, mechanics, and other operations people. But for each person directly employed, at least three would be needed to build the airplanes, the engines, the accessories, the instruments, and refine the fuel. Back of these would be workers to produce the raw materials, steel, aluminum, rubber, and agricultural products; and also

the tradesmen to supply and serve the families of all these workers. Thus the total employment resulting from feeder airline operations would be large enough to materially help solve our postwar unemployment problems.

We are living in a technological age. It is necessary that we lead, not only in research and development but also in the use and application of these technical advancements. We have seen the great and wealthy nation of China kicked around by a much smaller nation which is inferior in every way except that it is more advanced technologically.

Our battle casualties in this war have been much less than those of the enemy. One reason for this is that our men are more mechanically minded —a great help in fighting a mechanized war. We must remain the most mechanically minded nation even while we work for a permanent peace.

When we contemplate the destruction that has been rained on other cities of the world, we know that we must never allow another people to be more advanced aeronautically than we are. If our people are to know and understand aviation, it is of national importance that we provide means for them to use it—a good enough reason for extending air transport to our smaller cities and towns.

This would be necessary even if substantial government expenditures were involved. As we have seen in an earlier article, little if any subsidy will be needed, a fact which makes feeder airlines a national necessity.

Aircraft Investors Seen Facing Lower Dividends

By **RAYMOND L. HOADLEY,** *Financial Editor, "Aviation"*

But our financial analyst considers this a healthy, normal condition between war and peacetime operations—one that should not greatly affect equity values.

WHEN THE DIRECTORS of United Aircraft decided last month to reduce their regular June dividend from $1.50 to $1 a share, Wall Street brokers immediately advised their clients to expect a general downward trend in dividend payments by aircraft companies. They were probably right.

United Aircraft holds one of the strongest positions among aircraft makers in more ways than one, so when this big integrated company reduces its stockholder payments to the tune of $2,656,000 annually, it is not only news but also an action bound to influence the near-future dividend policies of the rest of the industry.

As a matter of fact United probably would be about the last aircraft company that Wall Street would pick to cut its dividend. Its earnings for the first quarter of 1945 were published shortly before directors took dividend action and showed profits of $1.21 a share on sales of $165,000,000. (Back in 1936 when United declared its first dividend, sales for the entire year came to only $22,000,000 while earnings were equal to 76c a share.)

United has made an enviable dividend record for a company in this comparatively young industry. Formed in 1934 through the reorganization of the old United Aircraft & Transport Corp., it was one of the first aircraft concerns to place its common stock on a regular dividend basis. Payments have been made in every year since 1935.

But there is more significance than its dividend record behind United's new ultra-conservative policy. The company has back of it some excellent banking connections. National City Bank of New York, second largest bank in the United States, was in on the company's formation, and Gordon Rentschler, president of National City, is a brother of Frederick Rentschler, chairman and a founder of United. Joseph P. Ripley, one of the directors of United, is chairman of the investment banking firm of Harriman, Ripley & Co., and he has been active in the past financing of United Aircraft, United Air Lines, and other aviation companies.

Early in the war, United's directors foresaw that its capital was inadequate for the wartime expansion that lay ahead. So in the forepart of 1942 an issue of more than $25,000,000 in preferred stock was sold to provide additional working capital. By the end of 1944 the company had current assets of $182,675,000 against current liabilities of $88,675,000. At the same time net worth stood at $94,000,000 compared with $74,000,000 in 1942 and only $18,000,000 in 1939, the year United first felt the impact of large British and French war orders.

And as far as reserves were concerned, United had set aside $2,726,000 from profits by the end of 1944 as a reserve for write-offs of excess expendable tools and supply inventories as well as $32,475,000 as a reserve against reconversion to postwar conditions.

Nevertheless, while sales and earnings still reflect wartime conditions, United has taken the lead in reversing the aircraft dividend upward trend, a rise which has continued steadily since 1939. In so doing Chairman Rentschler explained that with the end of the war in Europe and the closer proximity to final victory, extremely serious problems confront the aviation industry in termination and reconversion.

While he feels that in time these problems will be effectively solved, he believes that the cornerstone of our air power is a going, healthy aviation industry, and the "directors and management of United Aircraft believe that through this period a strong financial position must be maintained."

Thus it seems probable that most of the other aircraft companies shortly will follow United's lead and cut their dividends, even though some of them may continue earning their present payments by a comfortable margin as long as the Pacific war lasts.

What will be the effect upon stockholders of wholesale dividend reductions, aside from the obvious loss of income? Probably very little since the stock market never has paid much attention to the wartime dividends disbursed by the aircraft companies—or to their wartime earnings, either, for that matter.

It is interesting to note that following the reduction in United's dividend the stock continued selling part way between the high and low for the year.

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Utility Is the Range-Finder In Civil Plane Market Forecasts

By **NEIL B. BERBOTH,** *Development Div., Fairchild Engine & Airplane Corp.*

Here is a vital approach to the problem of gaging what part of the consumer's income our aviation industry may translate—via tax and competitive factors—into a thriving personal-craft business.

TO ADEQUATELY ASSESS possible personal aircraft markets it is first necessary to define utility as applied to personal transportation, for the personal plane must be regarded as a means of moving people from one place to another.

People travel for one of two reasons: Business or pleasure. These, in turn, represent three classes of utility.

First, there is *ultimate utility,* the ability to go anywhere at will, either between specific places for a particular purpose, or merely traveling for the sake of travel. Second, there is *limited utility,* the ability to travel between specific places for a particular purpose or merely to travel for the sake of travel, but with limited ability to go anywhere at all either because of speed or medium of travel. Third, there is *restricted utility,* the ability to move about merely for the purpose of moving, with no specific place to go and little object in going, restricted by speed, medium of travel, service facilities, and avigational facilities.

To date the automobile has achieved the closest approach to ultimate utility on land, limited only by its speed, and suitability of highways, from accomplishing longer-distance business and pleasure trips within restricted time periods. Personal airplane transportation to date has, by and large, achieved its best measure of success with restricted and to some extent, limited utility—that is, cross country flying for pleasure or flying for sport with no particular destination and purpose other than the accomplishment of moving through the air.

It has been, for most people, a sport or end in itself, rather than the means to an end. This characteristic must change before a reasonable degree of ultimate utility may be achieved. There is the exception of the flying salesman, usually selling aviation products, and the executive owner constituting a special class and demanding a higher type of plane than the true personal-owner type.

Neil Berboth of Fairchild's Development Division not only injects some new thoughts on estimating personal plane market potentials, he presents new methods of reaching them. Realizing that aircraft manufacturers will be competing with many other producers for that all-important consumer's dollar, he goes further to present ranges based on penetration of the market whereby individual producers, distributors or dealers can, on the basis of their own positions, more clearly judge what they may anticipate in the battle for sales.

The question, then, is what degree of utility may feasibly be attained by the airplane in the near future, and what requirements must it meet in order to attain this utility? Here lies the possibility of injecting some new thought into a well worn subject.

To attain ultimate utility, a vehicle must be capable of operating to a place within short walking distance of any spot in urban, rural, and farm areas where people have a community of interest. This requirement eliminates the present personal airplane as a completely utilitarian transportation unit, unless sometime in the future some radical design innovation is achieved, such as the helicopter objectives. But we are concerned here with airplanes as they may be conceived in the near or postwar future, and for that reason must dismiss the idea of the airplane's attaining ultimate utility.

Therefore, if personal aircraft markets are to provide substantial means for the support and continued development of the aircraft industry we must look beyond prewar concepts for our potential markets.

Strong incentives for owning an airplane which may provide little practical every day utility and which will require additional investment above utilitarian vehicles must be

TABLE I — Money Spent For Personal Transportation (1952 As Typical of 1947-57 Decade)

Income Level	Consumer Units (000)	Average Income	Income for Current Consumption	Approximate % Using Personal Transport[1]	Annual Amount Spent for Personal Transportation
Under $1,000	17,350	$625	$550–970	35%	$133–175
$1,000–2,500	17,350	1,650	970–2120	62%	175–266
$2,500–3,500	5,650	3,100	2120–2980	68%	266–338
$3,500–5,000	6,800	4,200	2980–3600	75%	338–384
$5,000–10,000	1,955	7,000	3600–6000	95%	384–538
$10,000–20,000	347	16,000	6000–10,075	97%	538–915
Over $20,000	148	40,000	Over $10,075	100%	Over 915
All Levels	49,550	$1,950	$1,560	63%	$211

[1] J. H. Geisse, "Postwar Outlook for Private Flying."

sought largely in the field of limited utility. If the incentive for ownership can be stimulated in such fields as sports, touring, and long-distance business travel, people may gradually find more utility for their aircraft.

Americans have long accepted recreational motoring as a part of the national life; they make considerable use of the automobile for long business trips. It is estimated, for example, that 12 percent of the annual auto mileage —29 billion car miles—is in trips of over 200 mi., of which 25 percent is business travel. Approximately 7 percent, or 16½ billion car miles annually is used for trips of 30-40 mi., of which 75 percent is Sunday driving, with the balance business trips. Approximately 640,000 inboard boat miles a year are made in 30–60 mi. trips. Thus about 19 percent, or 46½ billion vehicle miles annually can be said to represent potential mileage which may physically be performed by the personal airplane.

It must be remembered, however, that the automobile is purchased primarily because it provides almost ultimate utility, and not for purposes representing limited and restricted utility, although it is used for such purposes. This factor will exercise a restrictive effect upon the potential market for personal aircraft.

What are the requirements of the personal travel market? To understand this, we must look back to its beginning. The automobile brought the speed, flexibility, and endurance necessary to bring long-distance personal travel within popular reach. If the personal airplane is to take an important place in our national economy it must be efficient and practical in these three respects as far as touring and business travel is concerned.

The airplane possesses greater inherent speed than the automobile, leaving flexibility of operation as the quality to be attained in order to achieve an expanded market potential, and it is this problem which faces the aircraft industry today. The problem has many aspects, most important of which are:

1. Necessity for many strategically located flight strips, water ports, and airparks, so that no inhabited or desirable spot in the United States will be more than a few miles distant. It has been estimated that this goal might require approximately 20,000 such ports. All ports should be lighted for night flying operations.
2. Necessity for complete ground service facilities at all, or almost all, of these ports similar to that provided the motorists.
3. Necessity for simplified avigation facilities for day and night contact flying, such as visual lighted location markers, etc.
4. Necessity for simplified airplane operation.
5. Necessity for simplified rules and regulations governing private flying.
6. Necessity for improvements in safety of operation of personal aircraft.
7. Necessity for inexpensive highway transportation facilities at all, or almost all, flight strips and airparks — such as low rate auto rental services, taxis, and bus lines.

These problems do not seem impossible of solution. Perhaps the most difficult is the airport program. Since the ports would perform a public service function similar to that of the highway, it would seem logical that they be constructed with public funds. This would not only provide considerable employment, but at the same time might be amortized and maintained to an appreciable extent by plane registration fees and gasoline sales taxes, as in the case of public highways.

Of the remaining six problems only one—simplification of avigation—presents major difficulties for solution. Many solutions have been suggested, most of them concerned with placing brightly painted location markers on all flight strips. Such systems, if properly lighted, would no doubt materially aid contact cross country flying, but they would not help achieve all-weather personal flying.

Achievement of this in personal aircraft is a long way off and appears to be possible only through further development of radar. Today's only means of achieving all-weather flying requires an expensive instrument rating and expensive instrumentation, both far beyond the means of most present and prospective personal plane owners. Yet it is obvious that even limited utility cannot be obtained until the private owner is able to go where and when he wants.

While limited utility can be achieved, it can only result from a consistent and progressive program by the aircraft industry, government regulatory authorities, and the Congress.

What, then, of feasible cost standards? The problem of initial and operating costs is at once a part of utility, and interrelated with it. Lower cost standards must be a part of increasing utility.

Before discussing past and future cost standards, it is well to define consumer cost standards and demands in terms of the number of consumer units and the amount which they may reasonably be expected to afford for personal aircraft in the 1947-57 decade. A consumer unit is one family group or one single individual, and there are now close to 42 million such units in the United States, representing approximately 98 percent of the purchasing power.

The average consumer unit spends approximately 8½ percent of its dollars on personal user-operated transportation, a percentage which has remained practically constant for more than 20 yr. If we assume that this trend con-

TABLE II—Annual Amounts Which Could Be Spent To Own And Operate A Personal Plane

Income Level (Dollars)	Approximate % Using Personal Operated Transportation	Consumer units (000)	Annual Amount Spent for all Personal Transportation ($)	Annual Amount Spent for Auto Transportation ($)	Annual Amount Allowed for Personal Plane Transportation ($)	Maximum Selling-price of Airplane ($)
Under 1,000	35	6,080	142–187	70–90	72–97	*
1,000– 2,500	62	10,075	187–225	90–145	97–140	*
2,500– 3,500	68	3,840	285–362	145–190	140–172	350–430
3,500– 5,000	75	5,100	362–411	190–200	172–211	430–530
5,000– 7,500	95	1,200	411–490	200–220	211–270	530–675
7,500–10,000	95	440	490–640	220–240	270–400	675–1,000
10,000–15,000	97	336	640–1,100	240–300	400–800	1,000–2,000
15,000–25,000	100	245	1,100–2,450	300–450	800–2,000	2,000–5,000
25,000–35,000	100	53	2,450–4,000	450–720	2,000–3,280	5,000–8,200
35,000–50,000	100	40	4,000–6,000	720–1,000	3,280–5,000	8,200–12,500
Over 50,000	100	30	Over 6,000	Over 1,000	Over 5,000	Over 12,500
		27,439				

* Assumption is made that there will be few, if any, airplanes priced under $350.

Note: Statistics on Consumer Units obtained through National Industrial Conference Board, Economic Almanac. Consumer units in various income levels over 5,000 based on similar relationship to 1935, National Resources Committee, Economic Almanac, NICB. Assumption is made that persons in income levels over $7,500 will spend a higher percentage for personal transportation, because percent of expenditures for subsistence is considerably lower. Automobile prices obtained from *Automobile Facts and Figures*, Automobile Manufacturers Association.

tinues; that postwar economic conditions may be reasonably healthy; that postwar tax rates will be decreased substantially from present levels that the established prewar trends of population, family groupings, and family income continue—then it can be estimated that during the decale 1947–57 approximately 11 million consumer units could spend $265–385 annually for personal transportation; 2 million consumer units could spend $395–540 annually; 350 thousand consumer units could spend $540–900 annually, and 150 thousand could spend over $900 annually. This would reflect an increase in personal transportation buying power of approximately 32½ percent over 1935–36 levels, and a decrease of approximately 15 percent under 1942 levels.

The average annual expense of owning and operating an automobile or small personal plane has been estimated at approximately 40 percent of initial cost. Ordinarily, the result of increasing expenditures for personal transportation has been the purchase of more expensive cars and increasing mileage operated; and to a lesser degree the same is true of the purchase of boats and, more recently, personal aircraft.

Let us assume the best possible circumstances—that is, that utility may be increased to the point where the American people will want to fly for long-distance business, pleasure, and sport to the extent that they will spend from $200–700 less for new cars, or would buy used cars from 2 to 3 yr. older than they would normally operate; and that increasing non-subsistence expenditures would include increases to 9.1 percent of consumption dollars expended for personal transportation.

If this were the case, and ownership of a plane presupposed ownership of an automobile, then approximately 7,000,000 individuals may afford to operate a used airplane, or else a new airplane only through the medium of flying clubs and airplane rental; another 732,000 may afford to own and operate their own new airplane costing from $1,200–2,500 or else operate a higher priced new airplane through the medium of flying clubs; another 255,000 could afford to own and operate a new $2,500–5,000 airplane or else operate a more expensive airplane through flying clubs; and another 135,000 persons in the highest income brackets may afford to own and operate new aircraft costing from $5,000 to about $10,000. Approximately 12,000 persons may afford luxury airplanes of greater cost.

This, then, appears to be the potential market for the 1947–57 period, in terms of maximum numbers of consumers and what they may afford. How many of this total will fly depends largely upon the utility and safety of personal airplane operation which we in the industry can achieve.

Utility is of prime importance. On the basis of the foregoing estimates, it appears that a substantial dollar volume market may exist for all classes of personal aircraft, costing from $1,200–10,000. The extent to which this broad market may be penetrated depends upon the usefulness of the personal airplane as a transportation unit.

Majority of the many estimated personal plane markets—ranging from 100,000 to 450,000 within ten years after the war—undoubtedly are based on the assumption that at least a good measure of increased utility will be achieved.

The lowest estimates generally assume that at the start of the postwar period utility standards may be similar to those of prewar days, with costs higher due to increased development, labor, and material charges. They also assume that, as the decade progresses, utility will increase fairly substantially, while costs will decrease more slowly as production increases and designs become stabilized.

The 300,000 estimate—the average of the range just mentioned—apparently assumes that cost and utility standards will improve perceptibly immediately following the war and that, as the decade progresses, utility will increase rapidly while cost standards decrease to levels approximately 50 percent below prewar levels.

It is difficult to predict which estimates may prevail. Either extreme may be realized, and any prediction would reflect the viewpoint of the maker, based upon his evaluation of the many factors involved, including surplus, the possibilities of overcoming increasing material and labor costs, and the speed and facility with which the industry and government may attack the problem of utility. There are many divergent views within the industry upon these problems.

However, in order for the estimate of 300,000 registered personal planes within ten years to be realized, it would be necessary for about 25 percent of the total potential of over 8 million consumers who may afford to own or, if not, to rent new airplanes, to do so, either by purchasing new planes personally or through flying clubs, or by renting new airplanes for long-distance travel purposes.

This compares with a prewar market penetration of about 2.5 percent and means that the public interest in personal flying must be developed to a high degree; that substantial and ever increasing utility and safety standards be attained; and that cost standards be lowered considerably to a point

TABLE III—Estimated Potential Personal Airplane Market, 1947-57

Number of Customers	Income Level ($)	Aircraft Price Range	Total Potential Dollar Volume (Millions of Dollars)	% of Max. Potential Market (Airplane Units)	Approx. % of Max. Potential Market (Dollar Volume)
12,000	Over 25,000	Over $10,000	Over $120x	1.5	6.7x
135,000	Over 15,000	$5,000–10,000	$675–1,350	11.8	28.4
255,000	10,000–25,000	$2,500– 5,000	$637–1,275	22.3	26.8
732,000	2,500–15,000	$1,200– 2,500	$878–1,830	64.4	38.1
1,134,000				100.0%	100.0%

Number of Customers	Income Level ($)	Aircraft Price Range	Explanation
7,300,000	2,500–10,000	$500–1,200 or $1,200–5,000	Second Hand Airplane.
19,005,000	Under 3,500	.....	New or second hand airplane through flying club. Expenditures $75–175 annually for new or second hand airplane rental.
27,439,000	Grand Total Customers		

x Average Aircraft Price Assumed as $20,000.

TABLE IV—Estimated Potential Personal Airplane Market, 1947-57, At Varying Percentages of Total Potential Market Penetration

	Penetration										
	5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Total Aircraft.....	66,900	133,800	267,600	401,400	535,200	669,000	802,800	936,600	1,070,400	1,204,200	1,338,000
Aircraft — Personal use.....	56,700	113,400	226,800	340,200	453,600	567,000	680,400	793,800	907,200	1,020,600	1,134,000
Aircraft — Flying clubs.....	7,300	14,600	29,200	43,800	58,400	73,000	87,600	102,200	116,800	131,400	146,000
Aircraft — Fixed base operators.	2,900	5,800	11,600	17,400	23,200	29,000	34,800	40,600	46,400	52,200	58,000
Aircraft — Over $10,000.....	600	1,200	2,400	3,600	4,800	6,000	7,200	8,400	9,600	10,800	12,000
Aircraft — $5,000–10,000.....	6,785	13,570	27,140	40,710	54,280	67,850	81,420	94,990	108,560	122,130	135,700
Aircraft — $2,500–5,000.....	13,690	27,380	54,760	82,140	109,520	136,900	164,280	190,660	219,040	246,420	273,800
Aircraft — $1,200–2,500.....	45,825	91,650	183,300	274,950	366,600	458,250	549,900	641,550	733,200	824,850	916,500

TABLE V—Estimated Potential Personal Airplane Market, 1947-57, At Varying Percentages of Total Potential Market Penetration (Dollar Volume)

Total (000)	Penetration— 5%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	$133,100–$262,750	$266,200–$525,500	$532,400–$1,050,000	$811,000–$1,578,100	$1,064,800–$2,100,000	$1,342,100–$2,630,500	$1,622,000–$3,156,200	$1,890,450–$3,682,900	$2,129,600–$4,200,000	$2,432,150–$4,728,300	$2,684,200–$5,261,000
Aircraft — Over $10,000 (000)	$ 12,000	$ 24,000	$ 48,000	$ 72,000	$ 96,000	$ 120,000	$ 144,000	$ 168,000	$ 192,000	$ 216,000	$ 240,000
Aircraft — $5,000–10,000 (000)	$ 33,925–$ 67,850	$ 67,850–$135,700	$135,700–$271,400	$203,550–$407,100	$271,400–$542,800	$ 339,250–$ 678,500	$ 407,100–$ 814,200	$ 474,950–$ 949,900	$ 542,800–$1,085,600	$ 610,650–$1,221,300	$ 678,500–$1,357,000
Aircraft — $2,500–5,000 (000)	$ 34,200–$ 68,400	$ 68,400–$136,800	$136,800–$275,600	$205,500–$411,000	$273,600–$547,200	$ 342,500–$ 685,000	$ 411,000–$ 822,000	$ 477,500–$ 955,000	$ 547,200–$1,094,400	$ 615,500–41,231,000	$ 684,200–$1,370,000
Aircraft — $1,200–2,500 (000)	$ 54,000–$114,500	$108,000–$229,000	$218,000–$458,000	$330,000–$688,000	$436,000–$916,000	$ 541,000–$1,147,000	$ 660,000–$1,376,000	$ 770,000–$1,610,000	$ 872,000–$1,832,000	$ 990,000–$2,060,000	$1,082,000–$2,294,000

where two-, three-, and four-place aircraft of higher utility may be purchased for from $1,000–2,500.

An additional important point must also be made: The capacity of the industry to achieve increasing production and reduced costs of commercial and personal planes while overcoming problems of personal plane utility will depend indirectly on postwar military aircraft production. If we keep a sizable Air Force and maintain a reasonable scale of research, development, and replacement production, we should, as a healthy and united industry, be able to meet the challenge of postwar commercial and personal markets for new and better aircraft.

To complete the picture, here is the method used for estimating the potential consumer market for personal aircraft:

Estimates of buying power are made on the basis of consumer units, which represent the total of family and individual buying units in the United States. For instance, in 1941 there was a population of 130,100,000, excluding institutional. This total population was broken into 33,000,000 family units and 8,550,000 single individuals, making a total of 41,550,000 consumer units.

According to projections made by the National Resources Committee, there will be in 1947 a total population of approximately 139,500,000, and in 1957, 148,500,000. Since 1900 there has been a steady increase in the number of families, accompanied by a consistent and regular decrease in the size of the family unit. If it is assumed that this trend will continue in the postwar period the consumer units in the postwar decade (assuming 1947 as first year of peace) will appear as follows:

Year	Population (000's)	Persons per Family	Total Family Units (000's)	Total Single Individuals (000's)	Total Consumer Units (000's)
1900	75,285	4.69	14,538	7,102	21,640
1941	130,400	3.68	33,000	8,550	41,550
1947	136,350	3.50	36.000	10,350	46,350
1952	141,350	3.35	39,000	10,550	49,550
1957	145,150	3.20	42,000	10,550	52,550

The population figures for 1947, 1952, and 1957 assume that the standing Army, Navy, and Air Forces will be higher than in prewar years, so that total institutional population will reach a high of 2.25% of total population.

National income has increased consistently since the turn of the century, from $677 million in 1900 to $90 billion in 1941, with the customary lapses during depression periods. Due to war conditions it went to $140 billion in 1943 and probably will go higher in 1944–45. If it is assumed that reconversion and economic readjustment can be accomplished with reasonable facility resulting in reasonably healthy economic conditions, and that national income may return to a level of approximately $10 billion above 1941 levels, increasing slowly with little fluctuation during the decade to approximately $110 billion in 1957—then the individual income trend would appear as follows:

Year	Per Capita Income	Total Consumer Units 000's	Income Per Unit
1900	$212	21,640	$738
1941	676	41,550	1,990
1947	718	46,350	1,990
1952	727	49,550	1,950
1957	740	52,550	1,925

Taking the 1952 figures as typical of the decade for the purpose of estimating the 10-yr. market potential, assuming that the relationship of consumer units and income brackets will return to 1940–41 standards, and further assuming that the 20-yr. trend of consumer expenditure for personal user-operated transportation will continue at 8.5 percent of the consumption dollars, we then arrive at the conclusions shown in Table I.

It has been estimated that the yearly cost of operating either high or low-priced planes or automobiles ranges from 40–60 percent of the purchase price. (J. H. Geisse, *Postwar Outlook for Private Flying.)* An optimistic assumption is that the over-all national average might be the lower, 40 percent. On this basis, the following table indicates the price automobile which could be owned and operated by consumers in the various income levels:

1952 (As Typical of 1947–57 Decade)

Income Level	Range From	Car Age	To	Car Age
Under $1,000	$330	Over 3	$440	2–3
$1,000–2,500	440	2–3	665	new–1
$2,500–3,500	665	new–1	850	new
$3,500–5,000	850	new	960	new
$5,–10,000	960	new	1,350	new
$10,–20,000	1,350	new	2,280	new
Over $20,000	Over $2,280	new		

The above prices represent an increase of approximately 32½ percent in transportation buying power over 1935–6 levels, and a decrease of approximately 15 percent under 1942 levels (assuming automobiles were available in 1942). In the past, as income expanded, the proportion of current consumption dollars expended on transportation has been maintained through increased new car purchases, purchase of higher-priced cars, and purchase of other personal transportation luxury items such as boats and, more recently, airplanes.

Another pronounced trend has been the increasing ratio of expenditures above subsistence only. The rate of increase for the past 30 yr. has been approximately 21 percent per decade. When the relationship of personal transportation expenditures to total expenditures is considered, this trend would theoretically amount to about a 7% increase in consumer dollar expenditures for personal user-operated transportation during the decade 1947–57. However, it has been established that the consumer may be expected to adjust his budget to allow for expenditures of 8.5 percent of his dollar for personal transportation, and this possible increase would normally be diverted to other non-subsistence items, such as foreign travel, education, recreation, etc.

The assumption is made that increased utility of the personal airplane may reverse these two normal trends to the extent that:

1. As income per consumer unit increases, consumers would operate used automobiles 2–3 yr. older than normally, or operate new automobiles costing from $200–700 less, or in the case of higher income consumers, oper-

ate one instead of two new automobiles or two low cost automobiles; and,

2. As non-subsistence expenditures increase in proportion to subsistence expenditures, such increases would include an increased percent of consumption dollars expended for personal transportation, to the extent of approximately 9.1 percent of total consumption expenditures.

On the basis of these assumptions, the results shown in Table II represent the annual amount which could be spent owning and operating a personal airplane, and the price airplane which this annual amount would support.

Undoubtedly there will be many persons in the lower and medium-high income brackets who will spend more than the amount indicated in Table II for personal aircraft, especially where families are small and savings, such as war bonds, have been established over a period of time. These are the people who will possess a more-than-average desire to fly as a hobby or pastime, and they will represent the backbone of the market. Their numbers are impossible of estimation.

However, the vast majority will tend to fall within or slightly above the price brackets indicated when effect of savings is considered. The principal reason is the strong desire of persons in all income levels for a variety of luxury goods and services, and the desire for a personal airplane will vie for consideration with other items, from larger homes to washing machines, until and unless the utility of the airplane is increased to the point that it becomes a practical necessity.

Allowing proper weight for these factors, and giving consideration to the effect of established long term savings in all income brackets which may allow consumers to "stretch a point", Table III may define the potential market for personal airplanes during 1947–57, on the basis of the assumptions developed heretofore. The term consumer unit is changed to "customer".

Estimates of purchasing power for all groups are based on the assumption that the tax rates in the postwar period will be substantially decreased from present levels.

Although Table III indicates that aircraft in the price range from $5,000–10,000 have almost as great a potential dollar volume market as aircraft priced from $2,500–5,000, it is necessary that the higher priced aircraft possess *distinct advantages* over the lower priced planes in order that this potential market be realized.

This would be the case throughout all four price ranges, and it accentuates the effect which cost and quality competition will have on the potential market for various aircraft. Among the qualities which may be the criteria through all price ranges are passenger and baggage capacity, cruising range, cruising speed, landing speed, simplicity of operation and flying characteristics, relative safety of operation, instrumentation, appearance, ease of maintenance, comfort, and flexibility of land and water operation.

In estimating the potential personal plane market at varying percentages of potential sales, it is necessary to make several arbitrary assumptions, as follows:

1. That 10 percent of the total of 7,300,000 customers who may afford new airplanes only through flying clubs will do so, and that there may be an average of five persons per club; resulting in a new airplane market potential of 146,000 units. That about 10 percent of these customers may purchase aircraft priced from $2,500–5,000, and that 90 percent will purchase aircraft priced from $1,200–2,500.

2. That 75 percent of total potential pilots may take approximately 25 hr. dual and solo instruction before purchasing aircraft; that there will be approximately 313,000 capable pilots in 1947—63,000 civilian registered and 250,000 military; that utilization of aircraft for instruction of these pilots may average 500 hr. annually; and that new aircraft will be utilized for instructional and rental purposes, resulting in a new airplane market potential of 58,000 units, of which about 2 percent may be aircraft priced from $5,000–10,000, about 8 percent priced from $2,500–5,000, and about 90 percent priced from $1,200–2,500.

3. That the balance of average annual utilization of aircraft by fixed base operators (approximately 250 hr.) will be sufficient to provide instructional and rental services to those 19 million customers who may not afford new or second-hand aircraft, but who may afford a few hours of instructional and rental flying annually.

No attempt is made to estimate new aircraft yearly production levels at varying percentages of market penetration, because of the multitude of unknown factors involved, such as disposition and life of surplus aircraft, life of new and prewar personal aircraft, intervals at which trade-ins will be effected, numbers of customers who will discontinue ownership after an indefinite period, etc.

Table IV shows the estimated potential personal airplane market vs. the percentage penetration of the total potential market, based upon the assumptions developed heretofore. All figures are estimates only, and the reader may, with the facts and figures contained herein, make different and varying assumptions and derive his own estimates.

Table V gives the 1947–57 estimated potential market, at varying percentages, in dollar volume, while Table VI gives estimated characteristics of postwar personal planes, compiled and estimated on the basis of information and specifications released by various manufacturers to date.

TABLE VI—Postwar Personal Planes Estimated Characteristics

Horsepower Class	Estimated Characteristics	Passenger Capacity 1	2	3	4
40–65 hp.	Ver	70–90 mph.			
	R	200–400 mi.			
	$	$800–1,000			
	Ca	$400–600			
	Chr	$2.70–4.00			
	Csm	4.5–5.0¢			
65–100 hp.	Ver		80–110 mph.		
	R		200–400 mi.		
	$		$1,500–2,500		
	Ca		$600–1,000		
	Chr		$4.00–6.70		
	Csm		2.8–3.3¢		
100–150 hp.	Ver		110–120 mph.	100–115 mph.	90–110 mph.
	R		400–600 mi.	400–500 mi.	300–600 mi.
	$		$2,500–3,000	$3,000–4,000	$3,500–4,500
	Ca		$1,000–1,200	$1,200–1,600	$1,400–1,800
	Chr		$6.70–8.00	$8.00–10.70	$9.30–12.00
	Csm		3.3–3.6¢	2.9–3.4¢	2.9–3.0¢
150–200 hp.	Ver		150–185 mph.	135–150 mph.	120–130 mph.
	R		700–900 mi.	600–800 mi.	400–700 mi.
	$		$4,000–5,000	$5,000–6,000	$4,000–7,000
	Ca		$1,600–2,000	$2,000–2,400	$1,600–2,800
	Chr		$10.70–13.30	$13.30–16.00	$10.70–18.70
	Csm		3.8–3.8¢	3.5–3.8¢	2.4–3.9¢
200–250 hp.	Ver				130–160 mph.
	R				700–900 mi.
	$				$7,000–9,000
	Ca				$2,800–3,600
	Chr				$18.70–24.00
	Csm				3.9–4.0¢

Ver = Cruising True Air Speed @ 60–70% Power
R = Maximum Range
$ = Selling Price
Ca = Annual Operating Cost — 150 hr. operation
Chr = Hourly Operating Cost
Csm = Operating Cost Per Seat Mi.
Note: Operating Cost include estimates of: (a) Direct Operating Cost — Fue & Oil, Maintenance Service, Replacement Parts; (b) Hangar Rental; (c) Depreciation; (d) Fairly Complete Insurance Coverage

MASS PLANE MARKET STARTS WITH SURPLUS

By JOHN FOSTER, JR., *Managing Editor, "Aviation"*

THE NATION'S BIGGEST aircraft marketing program now being conducted by the Reconstruction Finance Corp., designated by the Surplus Property Board as the agency for the disposal of aircraft, offers profit opportunities to dealers and distributors via two channels—through direct sales of planes, and through keeping their service organizations intact and busy repairing planes for sale.

This statement holds true on the basis of the record to date, for many alert operators have already re-sold many of the more than 11,000 planes which RFC and WTS have disposed of by sealed bid or, more recently, by fixed price. That additional profits can be made is evidenced by the fact that of the 20,000-odd aircraft now in surplus, approximately half are of types which might find service in the personal, fixed base operator, or transport fields. Both figures may be raised as more airplanes are declared surplus.

Considerable criticism has been leveled at the disposal agency but, RFC officials point out, none of the criticisms have been accompanied by tangible programs that can be made to work. Some of the criticism has been due to misunderstanding or lack of knowledge of the law—the Surplus Property Disposal Act—under which the program must be operated. While there is fairly wide leeway under the law, its basic principles are that the property must be moved.

RFC officials realize that, with so many airplanes, components, parts and accessories to be disposed of, any major move made will bring down the wrath of someone. As one official told AVIATION, "no matter what we do, somebody will say we're wrong, for the whole disposal program has some problems which simply can't be settled to everyone's satisfaction."

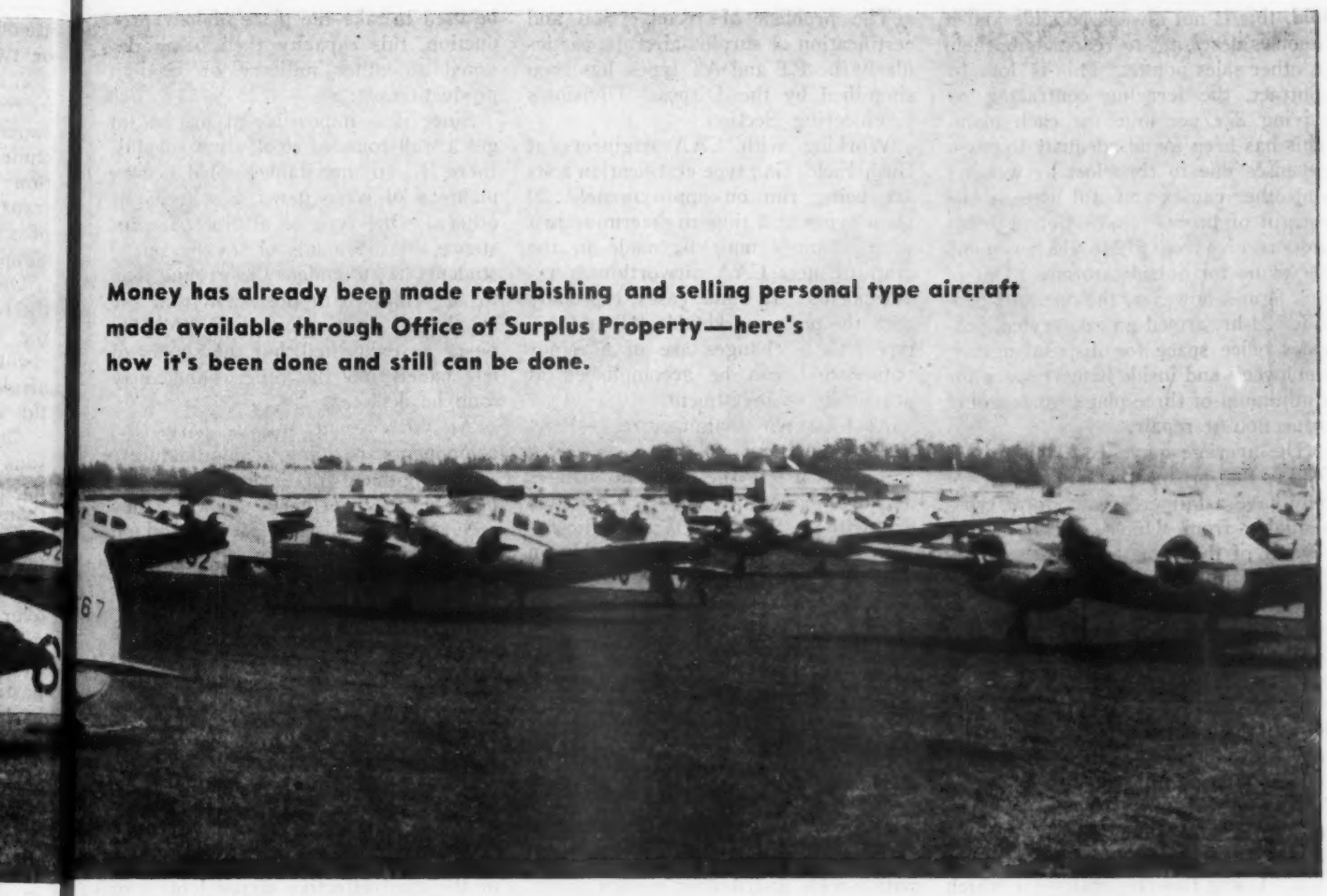
Recent changes in the over-all disposal set up put aircraft—along with all other surplus—under Hans Klagsbrunn, who heads up the new Office of Surplus Property, with Joseph P. Woodlock as executive director and James A. Garfield, who was chief of the surplus war Aircraft Division

SALES-STORAGE DEPOTS

Surplus War Aircraft Division
(As of Mar. 22, 1945)

Contractor	Field	Location	Disposing Loan Agency
Tye R. Bledsoe	Cimarron	Oklahoma City, Okla.	Kansas City
Willie Van Hassell	Hicks	Fort Worth, Tex.	Dallas
T. G. Walker	Bush	Augusta, Ga.	Atlanta
George Converse	Souther	Americus, Ga.	Atlanta
Jackson Hunter	Harris	Cape Girardeau, Mo.	St. Louis
Frank E. Hope	Augustine	Madison, Miss.	New Orleans
Darrell P. Maronde	Thunderbird II	Phoenix, Ariz.	Los Angeles
Lester B. Littrell	Cal-Aero	Ontario, Calif.	Los Angeles
Lyle W. Gadapee	Echeverria	Wickenburg, Ariz.	Los Angeles
John T. Wright	Hat Box	Muskogee, Okla.	Kansas City
W. N. Hearn	McKellar	Jackson, Tenn.	Atlanta
W. MacGraves	Grider	Pine Bluff, Ark.	St. Louis
Paul E. Wilcox	Ryan	Hemet, Calif.	Los Angeles
Robert H. Landers	Lamesa	Lamesa, Tex.	Dallas
Lee M. Corzine	Ponca City Mun.	Ponca City, Okla.	Kansas City
E. L. Ingram	Gibbs	Fort Stockton, Tex.	Dallas
Walter Kennon	Embry-Riddle	Union City, Tenn.	Atlanta
James E. Darby	Woodward	Camden, S. C.	Charlotte
George D. McCormick	Cuero Mun.	Cuero, Tex.	SanAntonio
Sam D. Williams	Thompson-Robbins	West Helena, Ark.	St. Louis
W. O. Smith	Victory	Vernon, Tex.	Dallas
James W. Carlyle	Gary	Blythe, Calif.	Los Angeles
J. E. DeCosta	Arledge	Stamford, Tex.	Dallas
Charles E. Mears	Ryan	Tucson, Ariz.	Dallas
G. C. McGee, Jr	Corsicana	Corsicana, Tex.	Dallas
Robert Gee, Jr	Palmer	Bennettsville, S. C.	Charlotte
Ben White	Fletcher	Clarksdale, Miss.	New Orleans
William W. Kelly	Harvey Park	Sikeston, Mo.	St. Louis
J. P. Flynt, Jr	Bruce	Ballinger, Tex.	Dallas
Ben R. Stroup	Municipal	Douglas, Ga.	Atlanta
Foster P. Forbes	Albuquerque Army Airfield	Albuquerque, N. M.	Denver

Money has already been made refurbishing and selling personal type aircraft made available through Office of Surplus Property—here's how it's been done and still can be done.



Biggest aircraft distribution job in nation is that which has devolved on RFC, agency charged with moving some 20,000 surplus warplanes. Over 8,000 —including many advanced trainers such as those shown here—have already been reconverted and sold by fixed base operators. (Press Association photo)

under Defense Plant Corp., as deputy director of aircraft disposal.

The new Aircraft Division, in turn, is divided into five sections: Aircraft Disposal, under E. L. Traylor; Parts & Components, under Col. A. E. R. Peterka; Educational Disposal, under Russell Heddleston; Maintenance & Salvage, under Stanford Stelle; and Administrative, under Thomas A Waddin.

Following recommendations of the so-called Pogue Report, made to the SWPA by the Surplus Aircraft Advisory Committee, surplus aeronautical products are classified under five headings: Class A, combat craft useful only for military purposes; Class B, transport craft, or larger planes useful primarily for scheduled operations; Class C, personal planes, those adaptable to private and fixed base operations; Class D, equipment and components, useful both for military and non-military purposes; and Class E, all planes and components not useful for either military or non-military purposes.

In operation, the program is being conducted along the following lines:

Aircraft declared surplus by the military are reported to the Aircraft Division in Washington, regardless of the location or classification of the craft. Lists of these planes are than sent to CAA engineers who indicate which types will be eligible for airworthiness certificates. Type-certificates are then issued for the eligible types. If the Aircraft Division so requests, the CAA will make tests of ineligible types to determine what changes or modifications will be necessary.

Prices of planes to be offered for sale come within a range established by formula—the lowest possible figure being the plane's salvage value, the top of the range being the "type price" which has been established as the result of experience gained in disposing of planes through the original sealed bid method.

The price formula has been worked out on the basis of original cost to the government, demand for the particular type, total time flown, time since overhaul of both engine and airframe, and other factors which make the final price determination a matter of routine for the field man.

Type price on the Cessna AT-17, for example, is $12,000 on planes costing the government from $28–32,000. From this $12,000, a flat $3,500 allowance is made toward reconversion costs on craft equipped with constant speed propellers and wings designed for a 5,400-lb. gross weight. An additional $1,500 allowance is given for planes equipped with fixed-pitch wood propellers and/or wings designed for 5,100-lb. gross weight. Minimum price on any AT-17 would be $3,900, the salvage value.

Type prices on Fairchild PT-19 and 23; Boeing PT-17; Ryan PT-22; and Naval Aircraft Factory N3N-3 types range from $875 to $2,400.

When a plane has been declared surplus it is delivered by the military to one of the 55 disposal centers operated by RFC. Twenty-four of these are designated as sales centers and are operated under contract by fixed base operators; 31 are sales-storage depots —former military training centers now owned by the RFC, which also are operated under contract. Both types and their locations are shown in the accompanying listings.

While an effort is made to have the planes delivered where they will be

sold, this is not always possible and it becomes necessary to redistribute them to other sales points. This is done by contract, the ferrying contractor receiving 27¢ per mile for each plane. This has been found adequate to cover expenses due to time lost by weather and other causes and still leave a fair margin of profit. Sales Center operators receive from $12 to $15 per month per plane for outside storage. Out of this figure, however, the operator provides 24-hr. armed guard service, provides office space for disposal agency employees, and inside hangar space for a minimum of three planes undergoing inspection or repair.

The average quota is 30 planes per field so that prospective buyers will not only have a fair cross section of types available from which to choose, but several of the same type so that purchases within the budget can be made.

Most aircraft purchases to date have been financed by the buyers—mostly fixed base operators—but it is pointed out that financing is available through the Smaller War Plants Corp., and RFC itself is considering a time-payment plan for the program.

In one case an operator purchased a Cessna AT-17 for about the top price of $12,000, to which he added some $3,000 for reconversion and certification. Using this one craft—for which he has repeatedly refused offers ranging as high as $22,000—as a demonstrator, the operator has to date secured firm orders for 20 similar jobs at prices averaging $18,000. Thus his shop is being set up to handle reconversions on a line production basis.

The problem of reconversion and certification of surplus aircraft, particularly the PT and AT types, has been simplified by the Disposal Division's Engineering Section.

Working with CAA engineers at Bush Field, Ga., type certification tests are being run on approximately 20 plane types at a time to determine just what changes must be made in the craft to meet CAA airworthiness requirements. In some cases, especially with the more marketable PT and AT types, these changes are of a minor nature and can be accomplished at practically no investment.

At least two manufacturers—Fairchild and Cessna—have prepared pamphlets listing the essential changes and are cooperating in every possible way with purchasers to facilitate licensing. Cessna, for example, in addition to listing the changes necessary, has prepared conversion kits, with parts essential to certification.

The Components & Parts Section, whose stock runs from complete airplane center sections down to cotter pins, is working to channel its surplus back through the original producers and distributors, or producers and distributors of like articles.

This system is being followed for two basic reasons: First, a complete, nation-wide distribution system is immediately available; and, second, it is felt that channeling the materials through these sources will have the least disruptive effect on the nation's economy. By routing this surplus material back through the original channels, it is believed, much of it can be used to take the place of new production, this capacity then being devoted to other military or civilian production.

Since it is impossible at present to get a well-rounded stock from surplus, there is an inevitable unbalance—a plethora of some items, a scarcity of others. One type of aircraft, for instance, in the hands of inexperienced students has a tendency to ground loop to the right, with the result that the supply of right wings will probably never be exhausted, but the supply of left panels, on the other hand, may soon be depleted.

At the present surplus parts and components are going to manufacturers on consignment for disposal. On surplus sold to government agencies, they receive a commission of 5% and on other sales 10%, plus, in each case, expenses such as for receiving, storing, inspecting, etc. Manufacturers distributing standard hardware items operate on a straight commission basis. This permits a higher total return for energetic sales efforts than it does for less efficient methods.

Manufacturers and distributors are required to hold back at least 20% of their surplus for direct sales to the public.

What may ultimately prove to be one of the most effective disposal units of planes, components, and accessories is the Educational Disposal Section. The law is definite on what can be done, but it is broad enough so that quite a flexible program is being set up. Outstanding feature, at least for recipients, is cost; for under the law only "nominal" prices need be charged for aircraft (which will not be used for flight), parts, and accessories. Thus under the schedule being set up, a school can get a four-engine bomber for $350 or a tachometer for $1—figures designed simply to cover handling and packing costs.

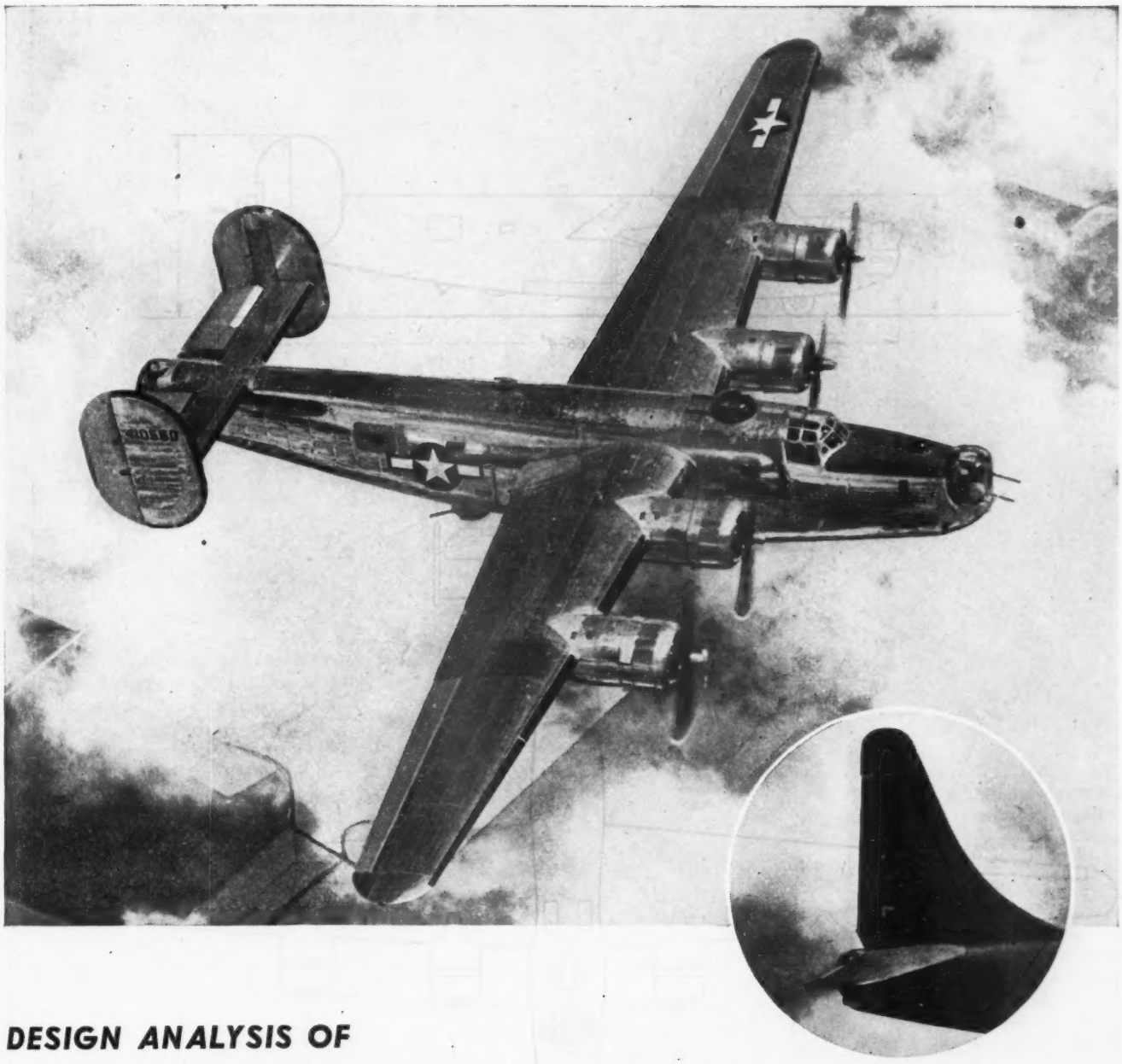
Under the law's definition of educational institutions, the commercial schools operated for profit cannot receive surplus material. There is no chance of such schools getting any unless the law is changed to include them.

As currently arranged, the program is starting with distribution, to some 30,000 schools throughout the country, of a catalog listing surplus items available. Listed are shipping weights by which the schools can determine what their final costs will be. At least until the end of the Jap war it is expected that shipments to schools will be made directly from AAF installations, even though the requests for the surplus are made directly to disposal headquarters in Washington.

SALES CENTERS—AIRCRAFT

Surplus War Aircraft Division
(As of Mar. 22, 1945)

Operator	*Airport*	*Location*	*Loan Agency*
Albany Aircraft Co.....	Albany	Albany, N. Y.	New York
Jennings Bros. Air Service...	North Grafton	N. Grafton, Mass.	Boston
Thor Solberg.....	Solberg-Hunterton	Readington, N. J.	New York
Cannon Acft. Sales & Ser....	Cannon	Charlotte, N. C.	Charlotte
Robert Slamp Flying Ser....	Ford-Lansing	Lansing, Ill.	Chicago
Brayton Flying Ser.....	Municipal	Robertson, Mo.	St. Louis
Central Aviation Corp.....	Municipal	Omaha, Neb.	Omaha
Des Moines Flying Ser.....	Municipal	Des Moines, Iowa	Chicago
Harte Flying Ser.....	Municipal	Wichita, Kan.	Kansas City
Thompson Flying Ser.....	Municipal No. 1	Salt Lake City, Utah	Salt Lake City
Clarence Ludwig.....	Ludwig-Sky Harbor	St. Petersburg, Fla.	Atlanta
Akron Airways.....	Municipal	Akron, Ohio	Cleveland
Cincinnati Air Ser.....	Lunkin	Cincinnati, Ohio	Cleveland
Hughes Flying Ser.....	Capitol City	Lansing, Mich.	Detroit
Lysdale Flying Ser.....	Victory	Minneapolis, Minn.	Minneapolis
Aviation Enterprises, Ltd....	Municipal	Houston, Tex.	Houston
Dakota Aviation Co.....	Municipal	Huron, S. D.	Minneapolis
Aviation Activities Co.....	Sherman	Concord, Calif.	San Francisco
Great Plains Aviation Co....		DuPont, Col.	Denver
Morrison Flying Ser.....	Municipal	Helena, Mont.	Portland
Cutter-Carr Flying Ser.....	West Mesa	Albuquerque, N. M.	Denver
Ashburn Flying Ser.....	Hybla Valley	Alexandria, Va.	Richmond
A. G. Becker.....	Bettis	Pittsburgh, Pa.	Cleveland
Western Skyways Ser.....	Portland-Troutdale	Troutdale, Ore.	Portland
Reno Sky Ranch, Inc.....	Reno Sky Ranch Apt.	Reno, Nev.	San Francisco
City of Morgantown.....	Municipal	Morgantown, W. Va.	Richmond



DESIGN ANALYSIS OF

CONSOLIDATED B-24 LIBERATOR

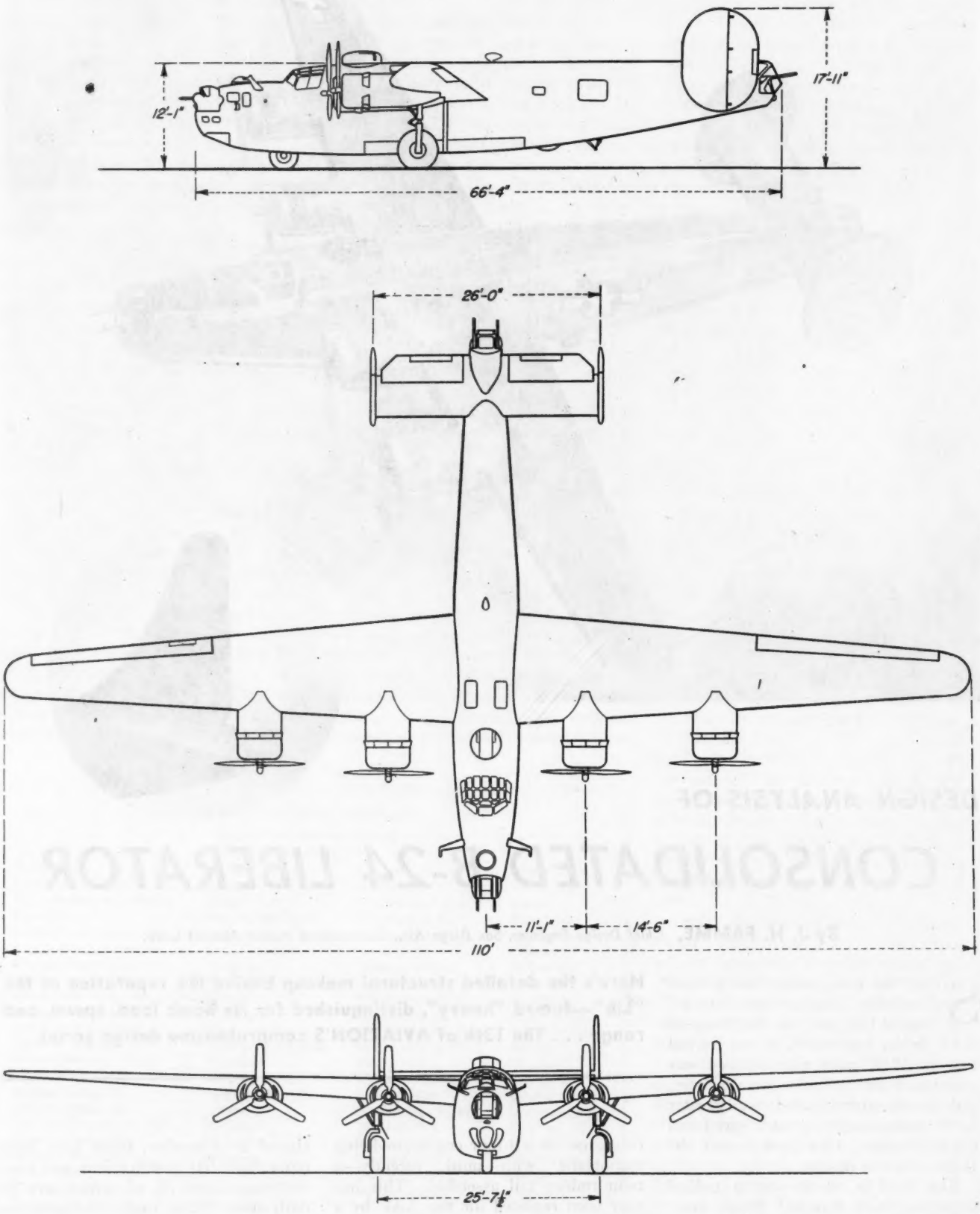
By J. H. FAMME, *Chief Design Engineer, San Diego Div., Consolidated Vultee Aircraft Corp.*

Here's the detailed structural makeup behind the reputation of the "Lib"—famed "heavy", distinguished for its bomb load, speed, and range . . . The 13th of AVIATION'S comprehensive design series.

SINCE the long range, heavy bombardment airplane was an accepted type and the backbone of AAF flying equipment, it was logical that in 1939, when Consolidated was asked to design a four-engine bomber, the specifications called for greater bomb load capacity, greater speed and greater range. Our answer was the B-24 Liberator design.

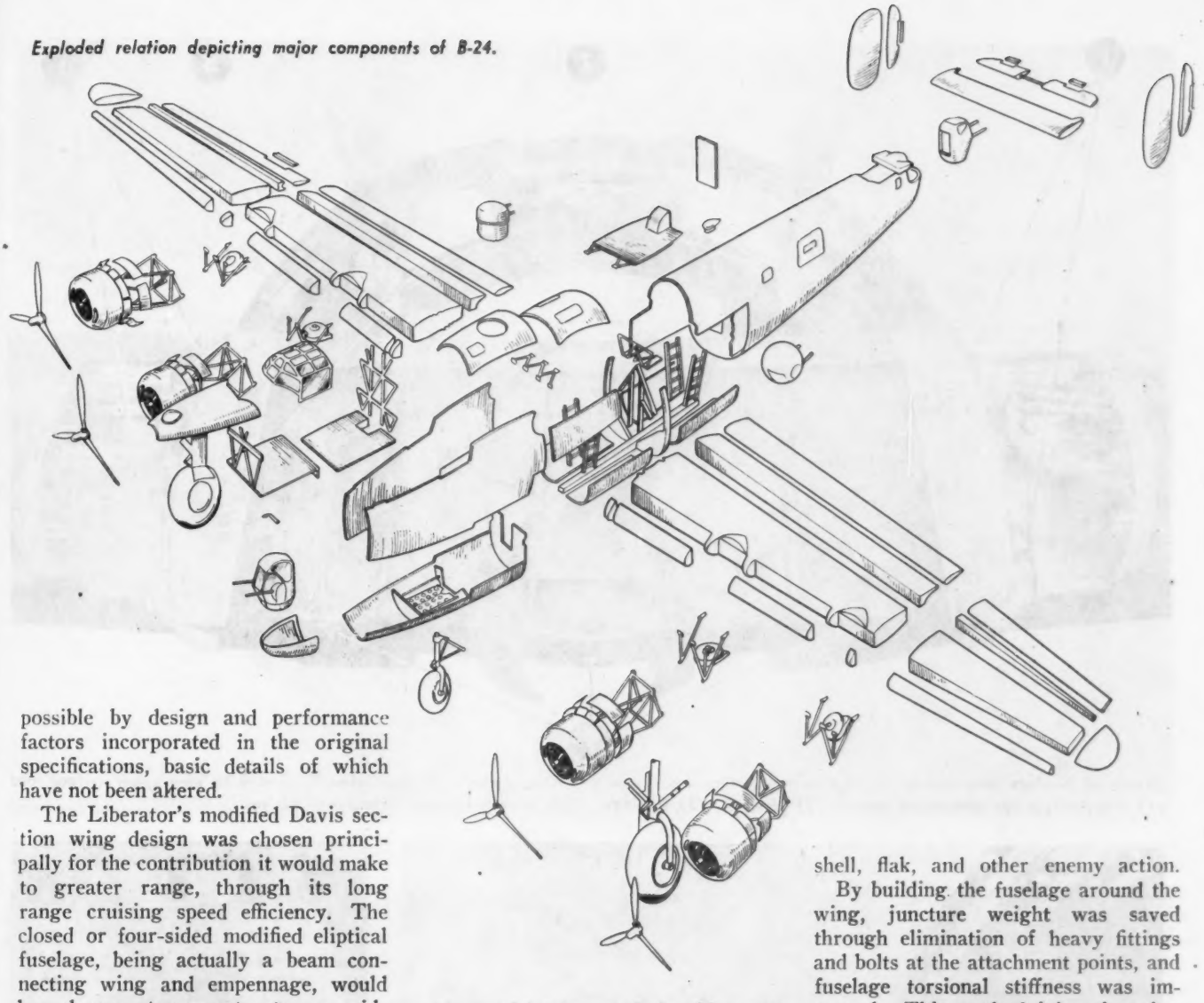
The B-24 is in no way a radical departure from accepted design practice. Instead, it is a particularly successful combination of best features of a number of fundamentally sound airplanes which preceded it on the drawing boards and production lines of the company. It is a four-engine, midwing monoplane with—until recently—a twin rudder tail assembly. This has now been replaced for the AAF by a single vertical fin-dorsal assembly—similar to that on the Navy Privateer PB4Y-2 which has been in production for over a year.

Although the Liberator was designed as a bomber, there have been more than 100 modifications and conversions—some 78 of which are in daily use. Other routine assignments include photographic, cargo, passenger, and route-exploration missions. Among its more recent modifications is a flying tanker conversion for ferrying gasoline. And all modifications were made



Three-view aspect of B-24 Liberator, showing major dimensions.

Exploded relation depicting major components of B-24.



possible by design and performance factors incorporated in the original specifications, basic details of which have not been altered.

The Liberator's modified Davis section wing design was chosen principally for the contribution it would make to greater range, through its long range cruising speed efficiency. The closed or four-sided modified eliptical fuselage, being actually a beam connecting wing and empennage, would be a deeper, stronger structure providing greatest space for bomb bays, crew quarters, armament, and operational equipment.

Fuselage

The fuselage is a semi-monocoque shell consisting of smooth skin reinforced with Z-type 24ST Alclad rolled stiffeners or stringers and transverse bulkheads and belt frames. The longitudinal stringers are generally spaced at about 6 in. intervals, with greater concentrations where required for added strength. Longerons are used only to carry loads around openings at bomb bays, access doors, and other points where the skin-stringer combination is broken.

Belt frames, to maintain fuselage shape, are .040 24ST Alclad lipped channel, notched to pass over stringers and spaced about 1½ ft. apart.

In the bomb bays, where belt frames and longitudinal stringers are interrupted, in the lower half of the fuselage, vertical stiffeners are spaced about 7 in. apart to avoid passing stringers around or over bomb bay door tracks. Side longerons are channel shape, 5 in. wide and 2 in. deep at their widest part in the bomb bays, tapering out 6 to 8 ft. in both ways.

Skin-stringer-bulkhead-belt frame structural design was used because strength is dispersed rather than concentrated in a few critical members, a distinct advantage in any assembly subject to combat damage—bullet, rocket shell, flak, and other enemy action.

By building the fuselage around the wing, juncture weight was saved through elimination of heavy fittings and bolts at the attachment points, and fuselage torsional stiffness was improved. This method joins the wing and fuselage by means of a continuous, riveted and bolted attachment around the periphery of the box structure of the wing formed by the upper and lower surfaces and the front and rear spars.

At the ends of the bomb bays are bulkheads connected longitudinally to a partial bulkhead in the center between the two bays by a beam which also forms the catwalk. Aft end bulkhead is a plate girder type built up of rolled sections and flat sheet. Upper part of the front bulkhead is a truss; the lower portion is flat sheet. The partial bulkhead between the two bays extends upward only to the wing to provide lateral support for the catwalk.

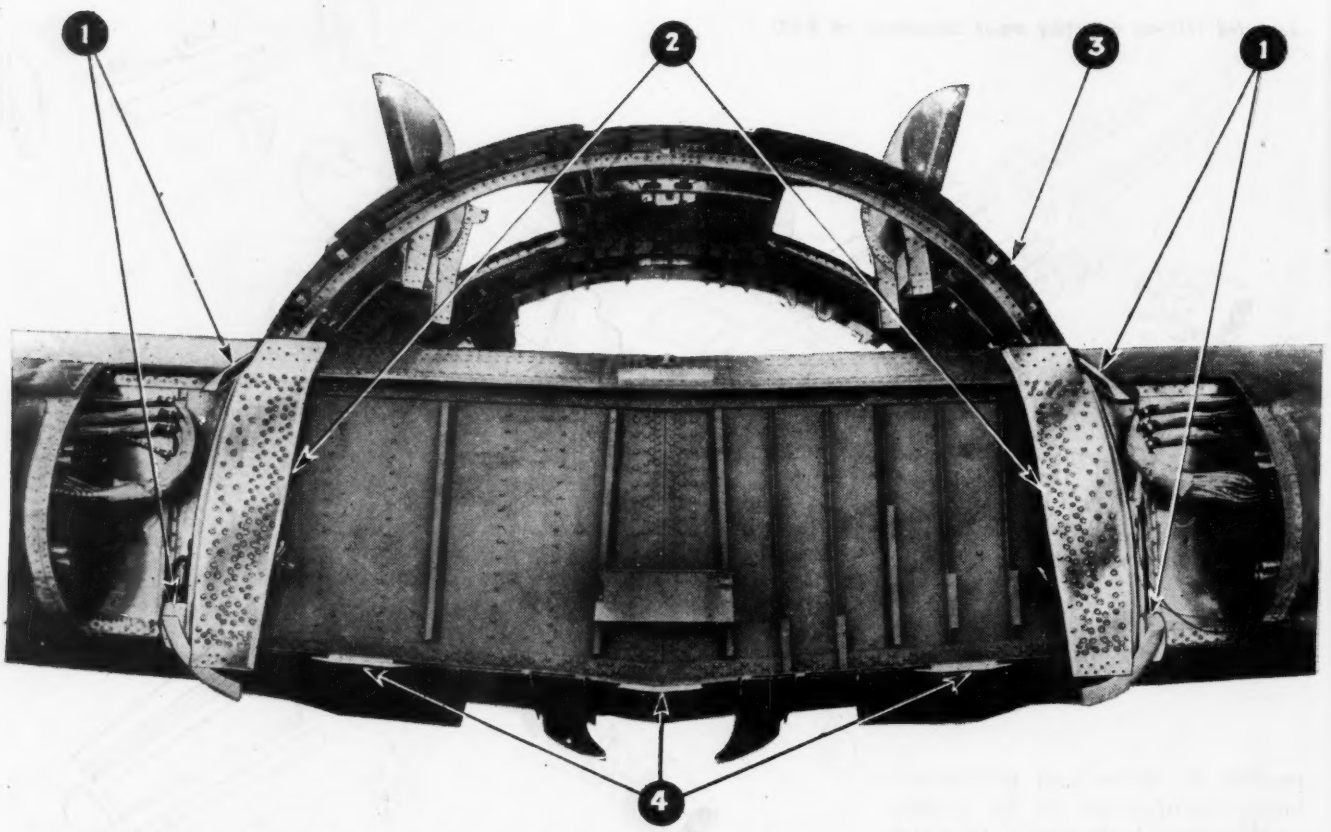
The catwalk through the bomb bays serves as a longeron and provides for transverse and longitudinal loads from the bomb racks. It consists of two U-shaped channels forming the sides, a corrugated Alclad top serving for the walk, and a smooth Alclad bottom forming part of the outside skin of the fuselage. Diaphragms of pressed sheet, spaced about 2 ft. apart maintain the cross-section of the catwalk. The cat-

Liberator Wing Data

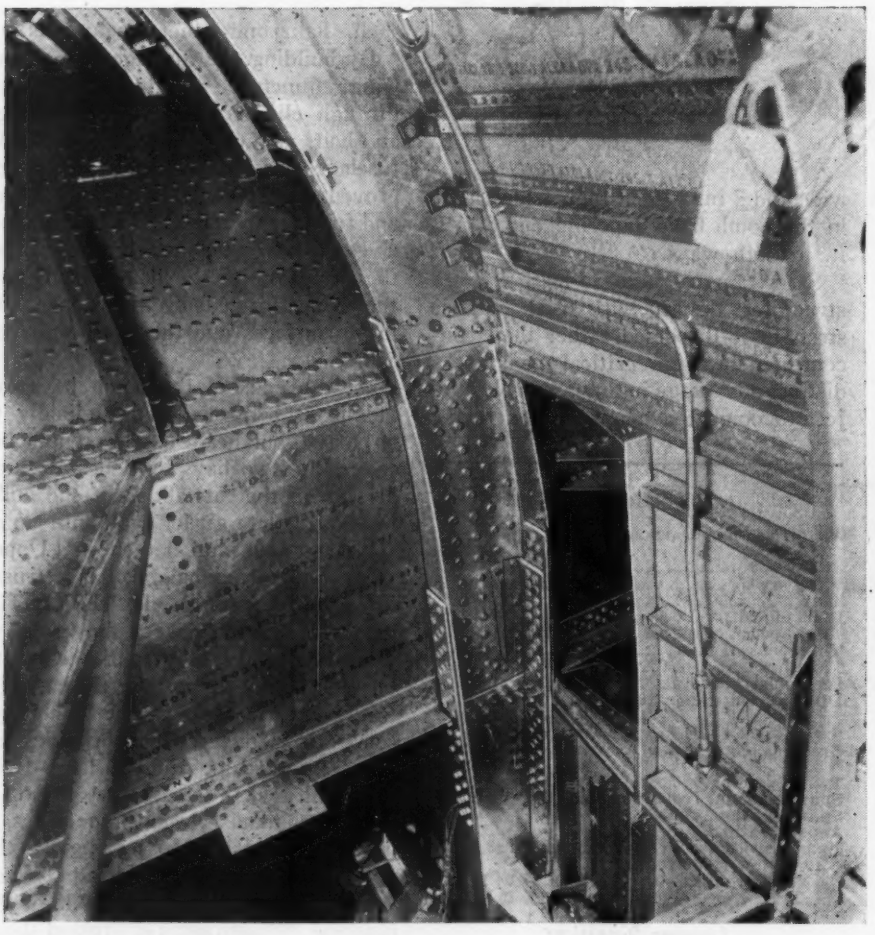
Airfoil section designation:	
Root	CVAC 22%
Tip	CVAC 9.3%
Wing area	1,048 sq. ft.
Span	110 ft.
Root chord	14 ft.
Tip chord	5 ft. 2-13/32 in.
Thickness at root	22%
Thickness at tip	9.3%
Incidence	3 deg.
Dihedral on upper 30% chord line	1 deg. 30 min.
Sweepback (L.E.)	3 deg. 30 min.
Trailing edge sweep forward	5 deg. 38 min.
Twist	None
Spar location, front	10% chord
Spar location, rear	66.2% chord
Aspect ratio	11.55
Mean aerodynamic chord, length	123.72 in.
Location relative to L.E.	
L.W. (chord—horizontal)	17.04 in. aft
Root chord—vertical	16.6 in. above

Fuselage Dimensions

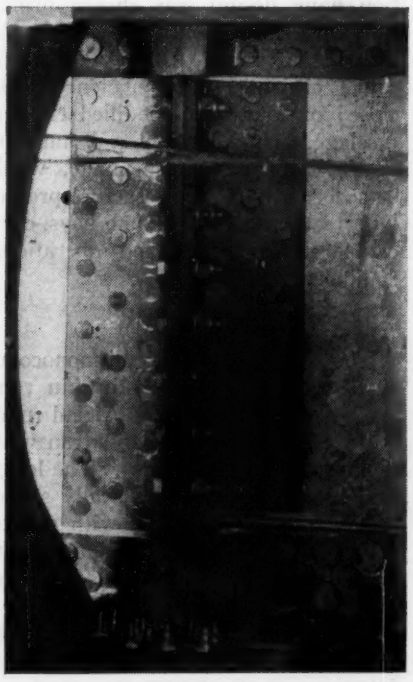
Length	66 ft. 4 in.
Maximum height	10 ft. 5 in.
Maximum width	7 ft. 5 in.



Details of fuselage attachments on wing center section, front spar; (1) Wing-to-fuselage attachment angles, (2) channels, (3) fuselage fairing (wing oval compartment) riveted to wing upper surface, and (4) wing-to-fuselage attachment fittings.

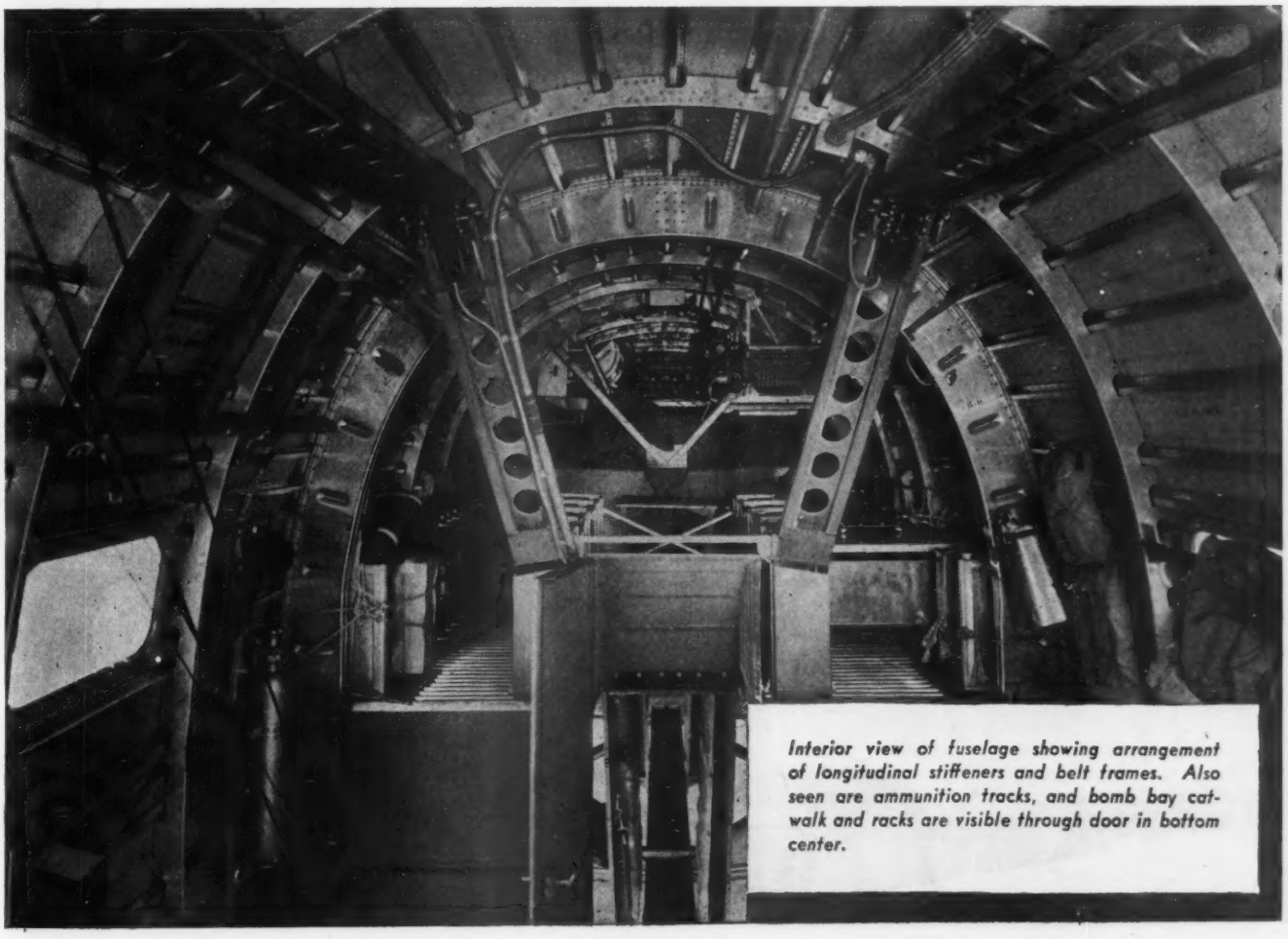


Fuselage-to-wing splice from rear spar side illustrating method of joining attachment fittings previously riveted to spar and fuselage, by means of rivets and bolts.

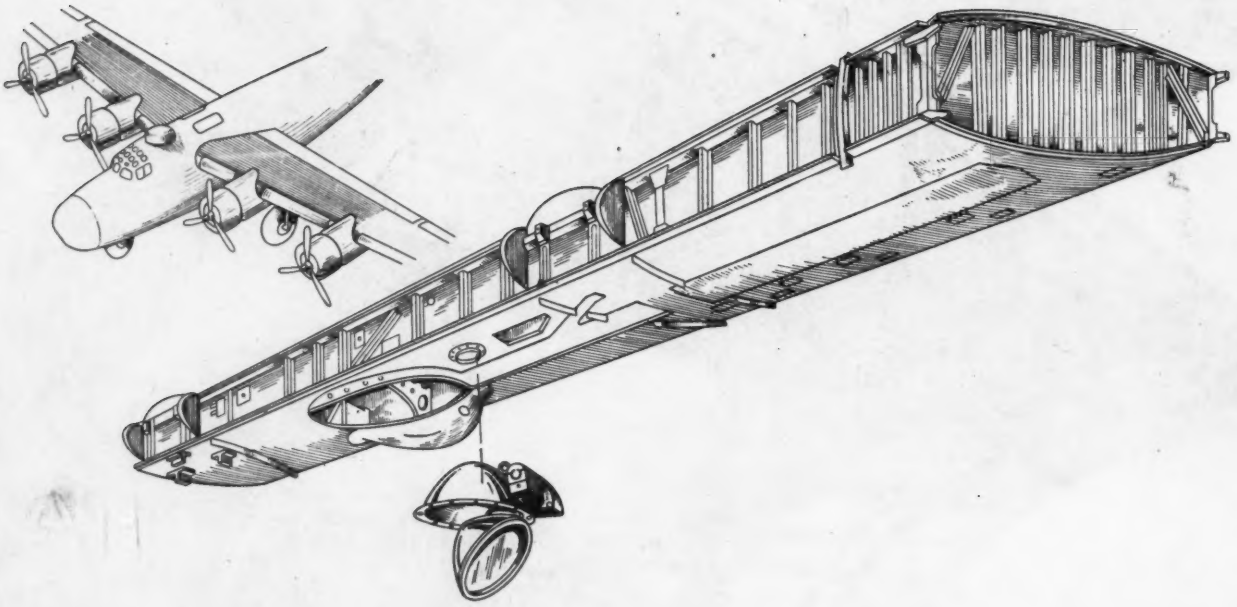


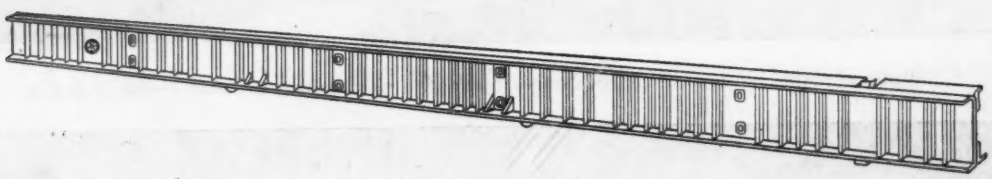
Typical spar splice in Liberator wing.

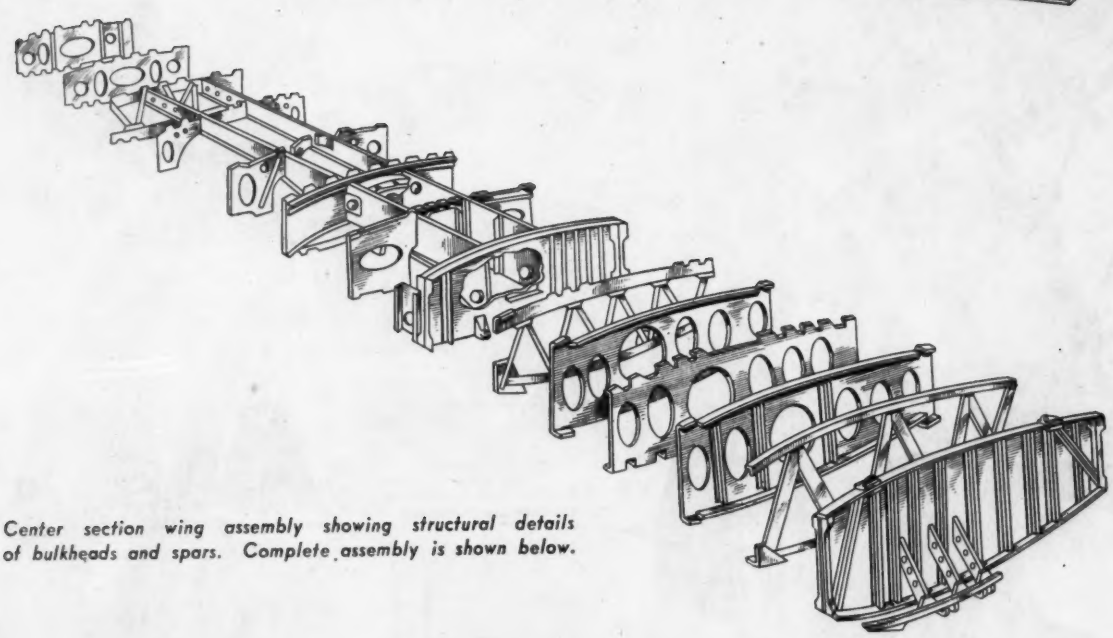
Structural details of fuselage interior above fuselage-to-wing splice. Life raft cradle is seen at lower center.



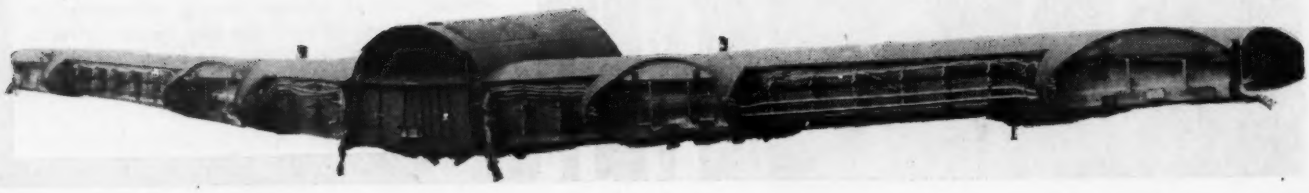
Interior view of fuselage showing arrangement of longitudinal stiffeners and belt frames. Also seen are ammunition tracks, and bomb bay catwalk and racks are visible through door in bottom center.







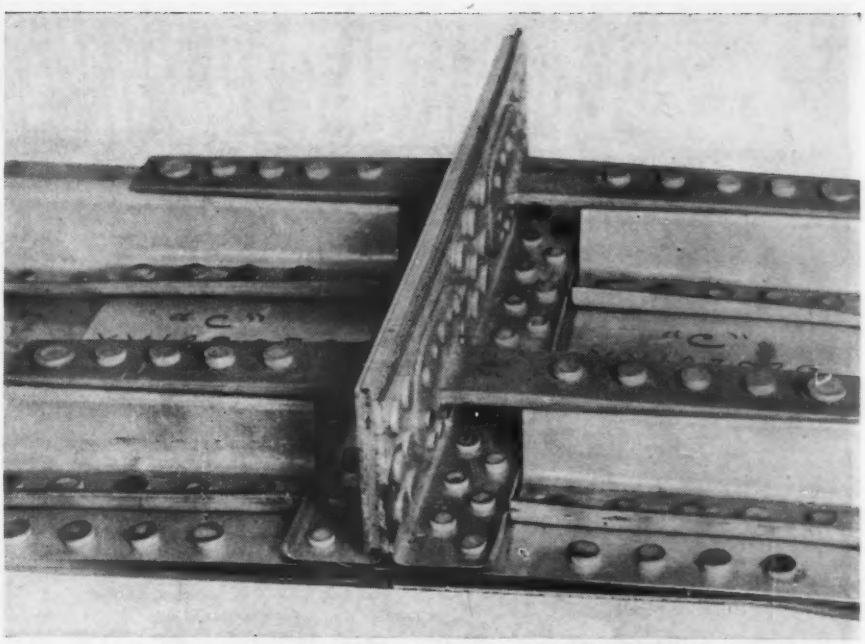
Center section wing assembly showing structural details of bulkheads and spars. Complete assembly is shown below.



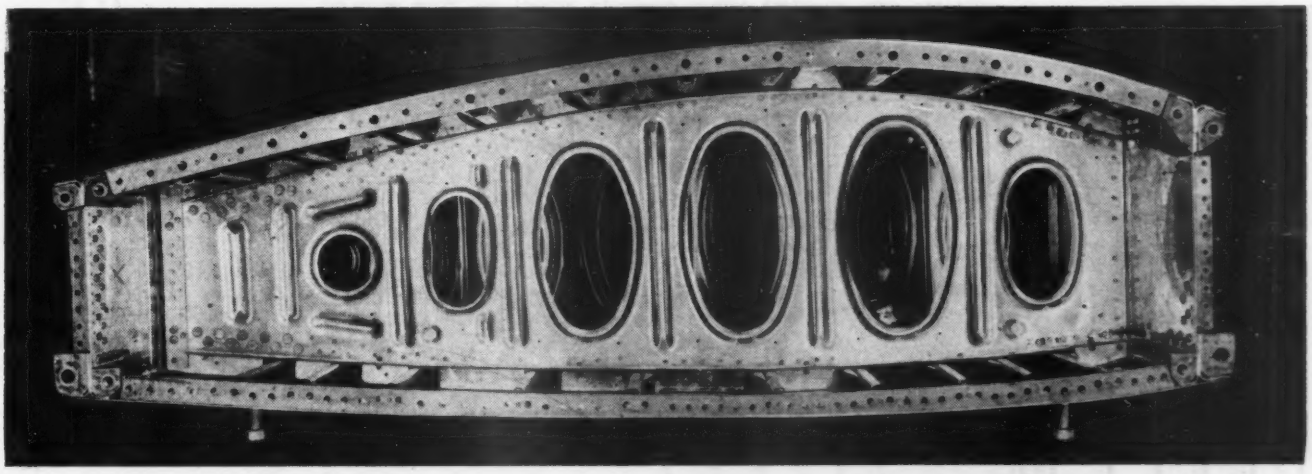
walk ends aft at a curved box beam which transmits loads to two longerons around the ball turret opening. These taper out 4 ft. beyond the turret opening. Forward, the catwalk tapers out ahead of the forward bomb bay. Around the nose wheel well, loads are passed through auxiliary longerons.

Nose wheel gear attaches at four points. Two upper attachments are to the floor truss of radio operator's compartment, the truss passing loads to the fuselage sides. Two lower attachments are to the main bulkhead of pilot's compartment, a plate girder built up of rolled sections and flat sheet, transmitting loads to the fuselage shell.

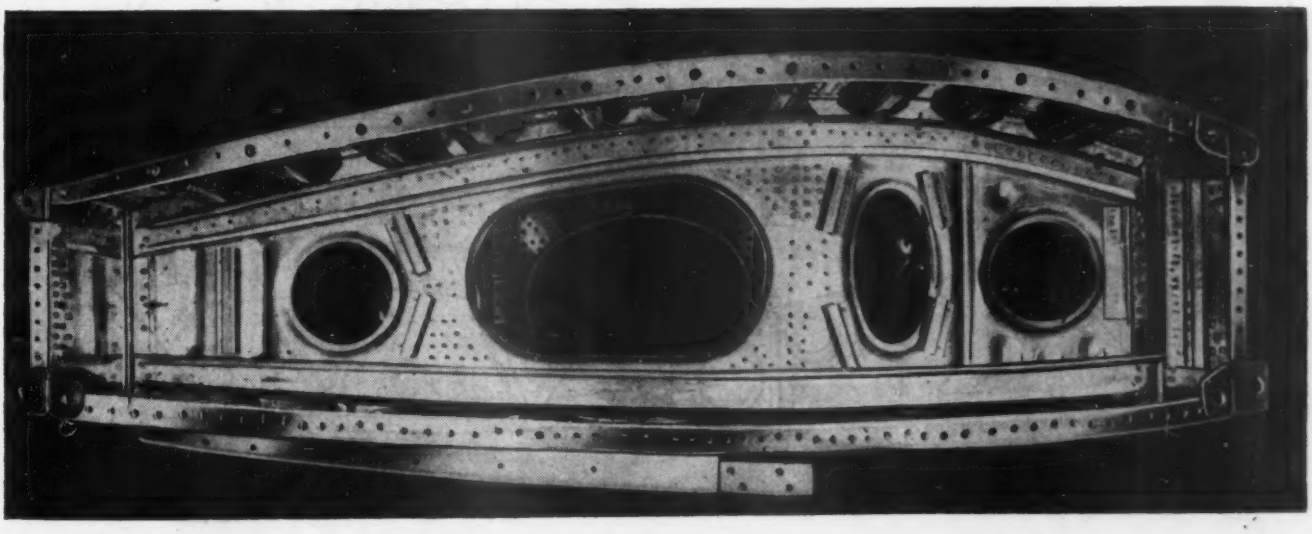
Vertical supports of the rear bomb racks are welded steel tube trusses in turn welded to gusset plates which are riveted to the rear spar of the wing, while forward racks tie to the lower surface of the wing by bolted fittings which pass loads to the wing internal structure. Bomb loads—because of this means of supporting the racks—are

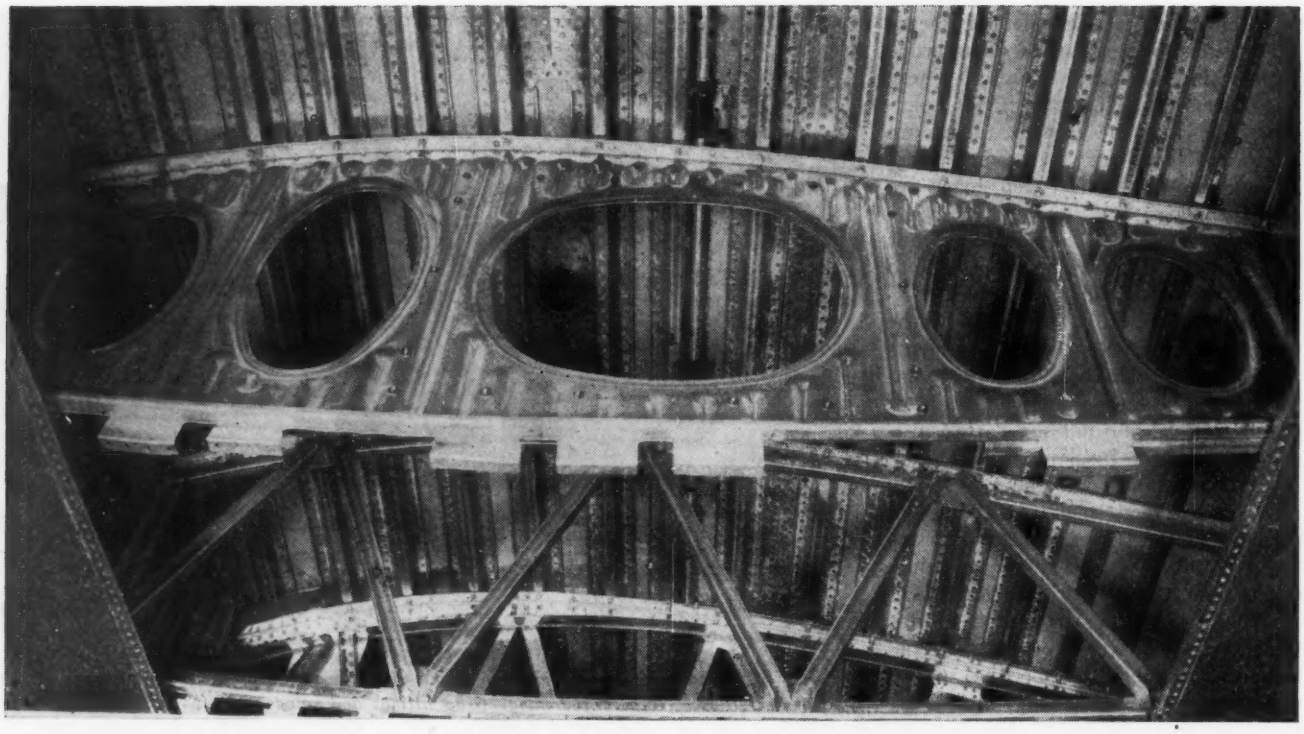


Closeup of typical wing hat-section skin splice at bulkheads located 147 in. from centerline and at centerline. Note forged flange strap fittings and splice plate.

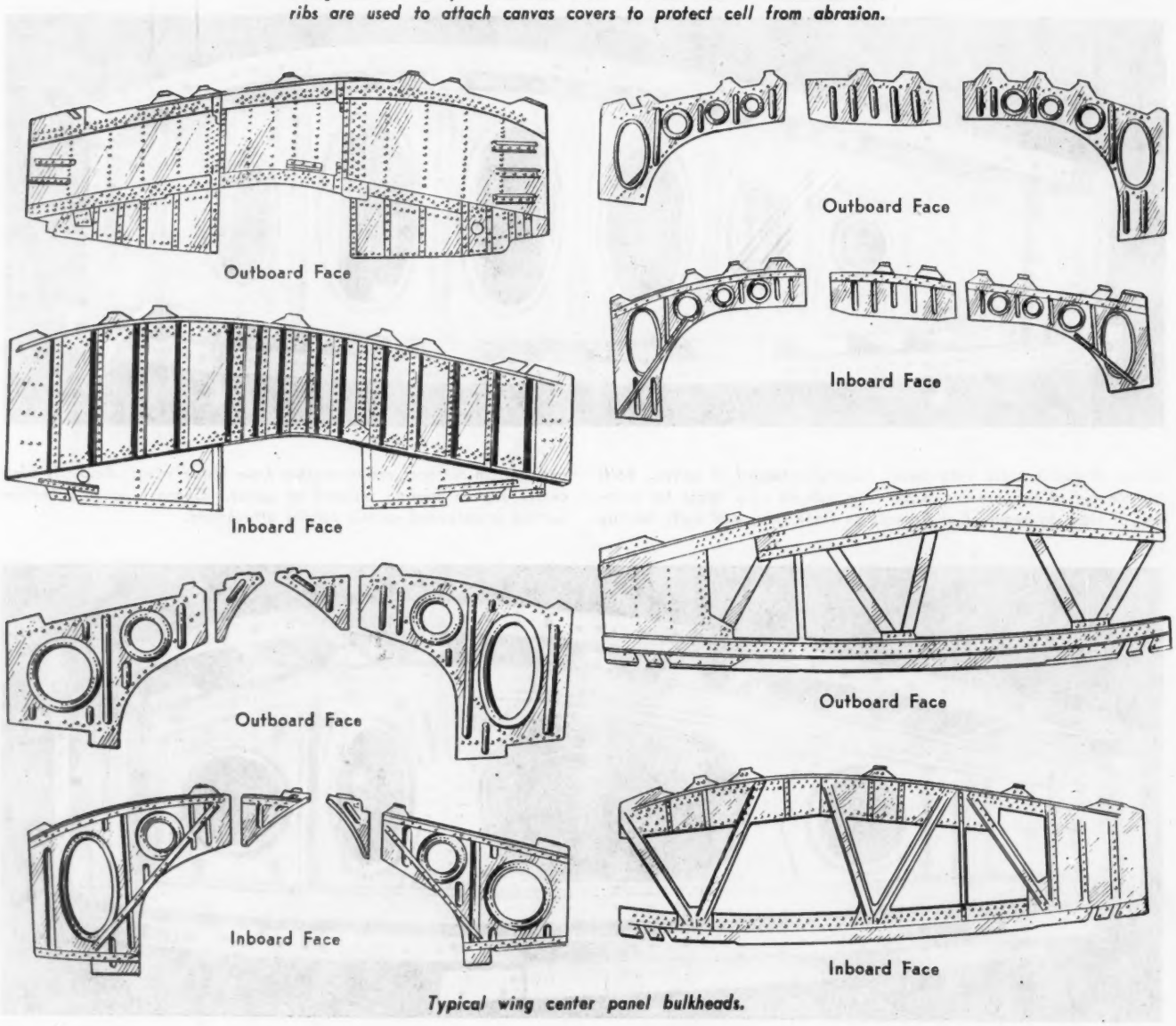


Shown at top is outer wing panel, looking outboard at splice. Bolts for channel at left are accessible from outside wing, those for member at right by removal of firewall on front spar, and bolts for top and bottom surfaces are accessible from inside wing. Below is wing center section looking inboard at splice. Channel beneath bottom surface is outboard nacelle fairing attachment.





Wing structure at space for fuel cells. Dot fasteners on bulkheads and ribs are used to attach canvas covers to protect cell from abrasion.



Typical wing center panel bulkheads.

actually carried by the wing, rather than to the wing by means of the fuselage. For load purposes, the wing attaches to the fuselage through bolting and riveting of channel type bulkheads to the front and rear spars of the wing.

Bomb bay doors are flexible and made up of corrugated section, 24ST Alclad, spot-welded and riveted to an outer Alclad skin. To open, they slide up on the outside of the fuselage by means of rollers attached to the ends of the corrugations and running in curved tracks.

Bombardier's compartment is merely a continuation of the fuselage nose section. It is standard monocoque construction of flat sheet supported by stringers and three bulkheads built of formed U-channels of Alclad and 24ST sheet. Ahead of bombardier's position, the fuselage supports a tub-like structure in which the forward turret is mounted. Supporting structure is carried on two short and heavy deep beams of 24ST Alclad, bolted to the foremost fuselage station bulkhead by heavy aluminum alloy forgings.

Pilot's enclosure is approximately midway between front of fuselage and leading edge of wing, and is faired into main portion of the fuselage.

The flight deck, immediately aft of pilot's position, has a floor slightly lower than pilot's floor. It carries drag loads from the main landing gear back to the wing and also supports radio equipment and radio operator.

Emergency exits are provided in the top of the fuselage above the bombardier and pilot positions, and in the bottom of the fuselage aft of the waist gun compartment for tail and waist gunners. Bombardier may also leave by way of the nose wheel door, and pilots and upper gunner may leave through the forward bomb bay. Waist and tail gunners can also use the waist gun windows.

Wing

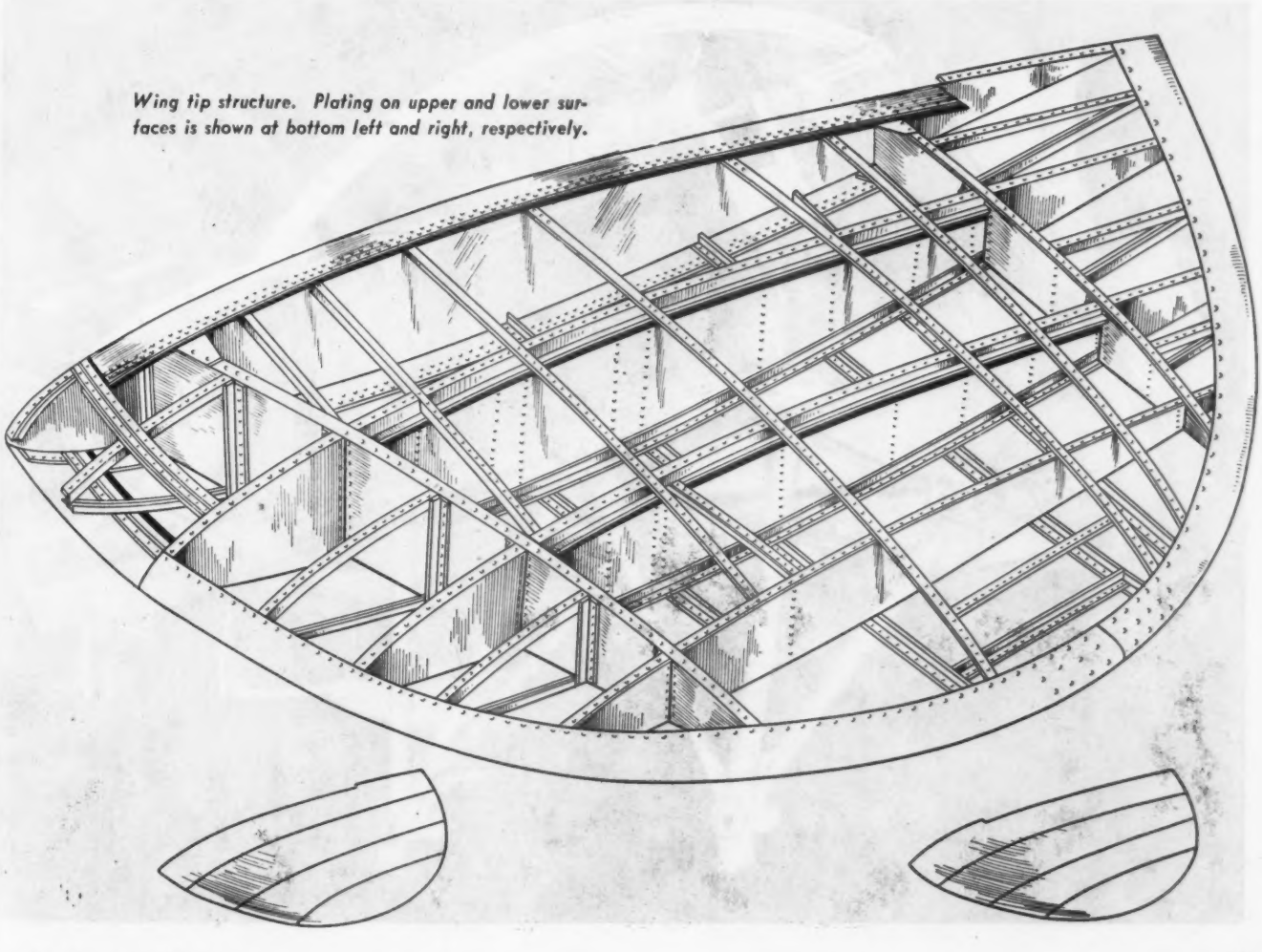
Design of the B-24 wing was based on a geometrically similar airfoil used with considerable success on Consolidated Vultee Model 31 flying boat. Ease of production was one of the main considerations in selecting this wing design.

The wing envelope is established by connecting corresponding percentage ordinates of the construction root and construction tip sections. Construction tip and root sections are normal to a chord plane. Each left and right chord plane is set at an angle of 3 deg. 26 min. to the horizontal, and the chord section on the plane of symmetry is established by intersections of the percentage point connecting lines. The tip is faired from the construction envelope in conventional manner.

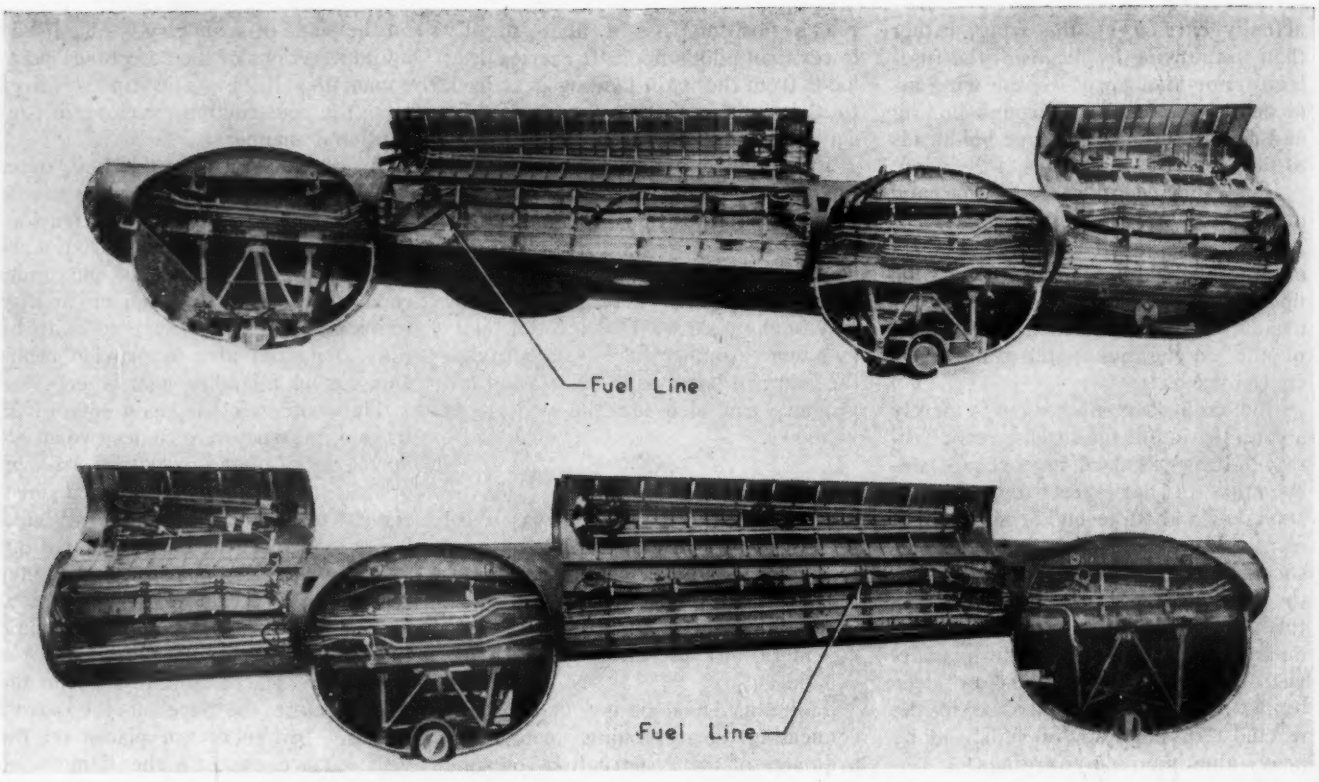
A center section and two outer panels comprise the main units of the wing and are mated by flush, tension-bolted splices. The spar locations were widely spaced to provide maximum room for fuel cells of sufficient capacity to insure the greater range specified by the AAF, and also to provide clearance for main landing gear wheels.

The center section has a span of 55 ft., and its structure includes two auxiliary spars of plate girder type, built up of heavy, rolled angles and flat sheet riveted to two of the main wing bulkheads to support the landing gear. Both main and auxiliary spars are Wagner type with Z-section vertical stiffeners spaced 4–6 in. apart, and rolled angle flanges. To eliminate joggles, the flanges are placed back-to-back on the web against the face of the paired angles. Stiffeners are placed on the web surface opposite the flanges, so that the components can be easily fitted together without appreciable loss of structural efficiency.

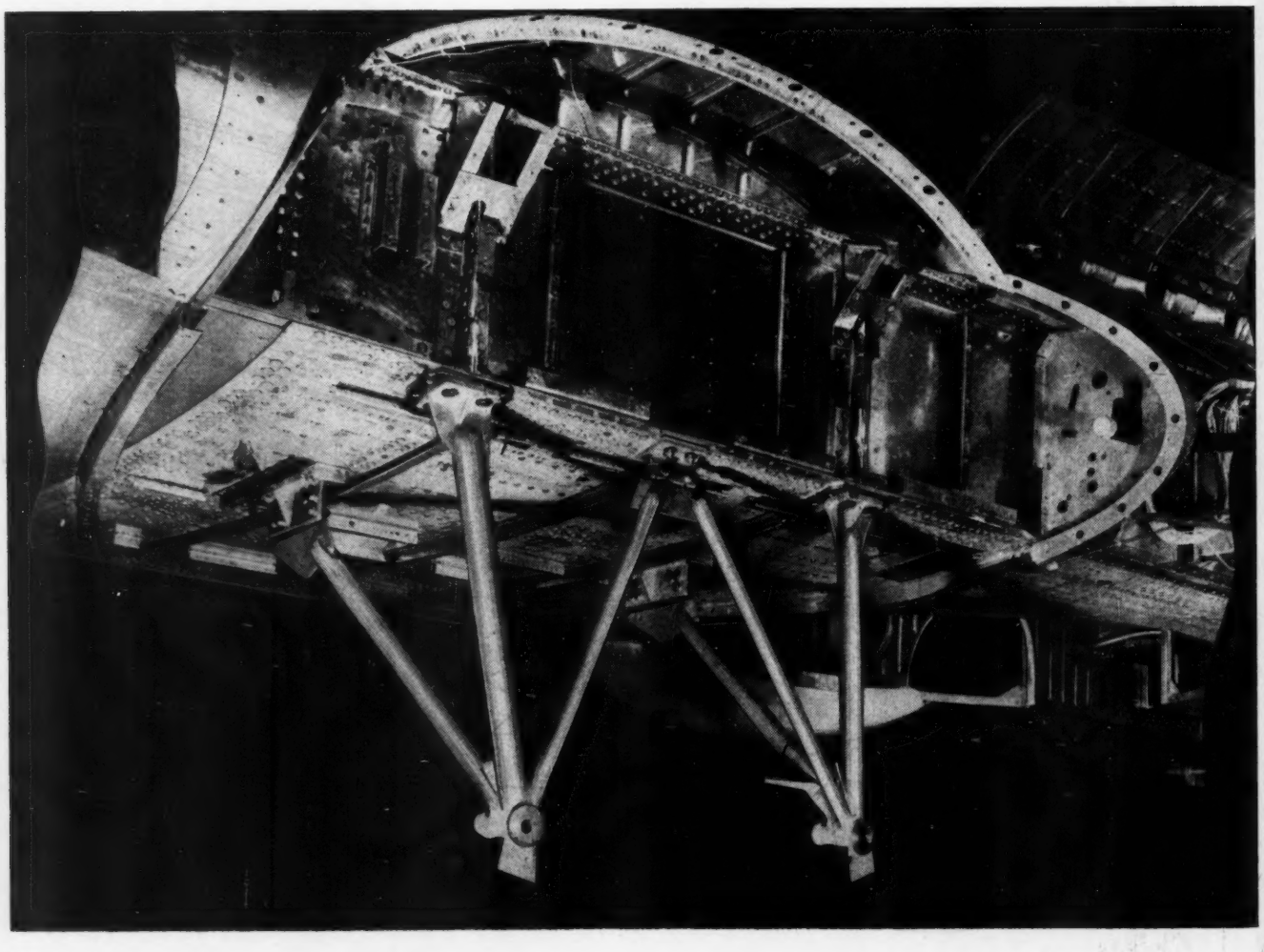
Bending loads are carried primarily by the upper and lower surface plate-

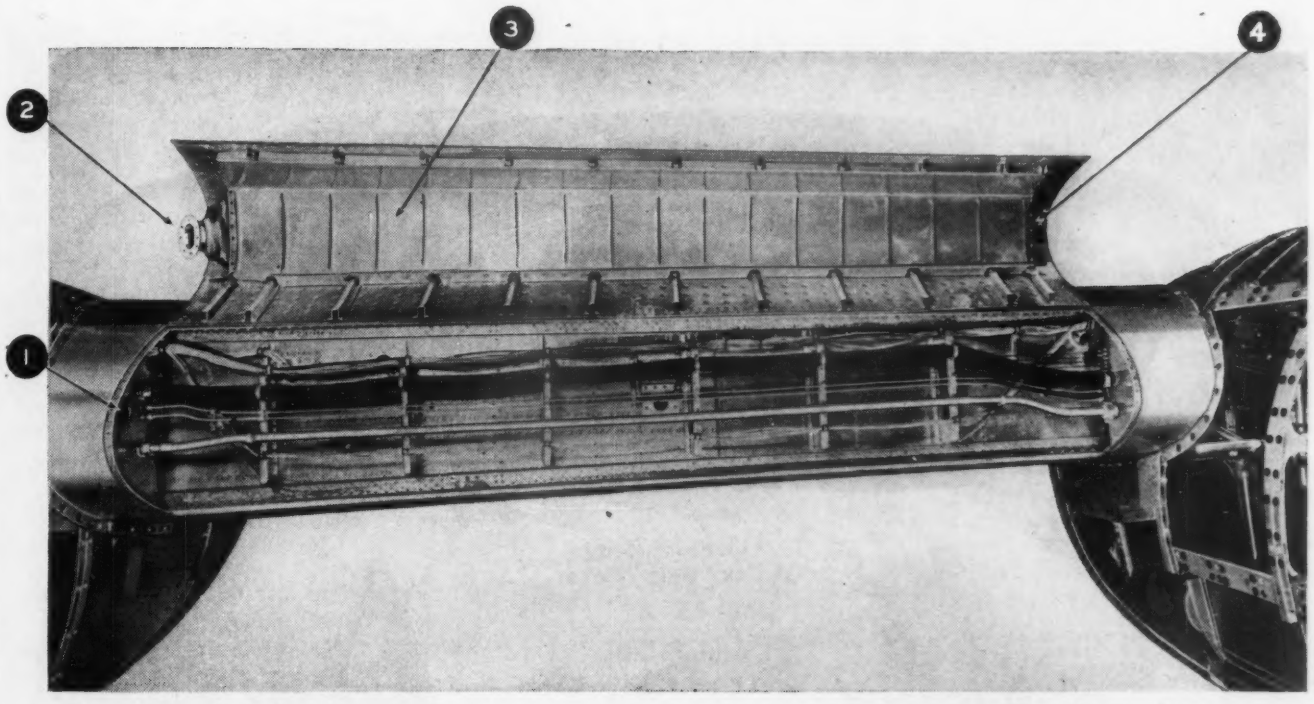


Wing tip structure. Plating on upper and lower surfaces is shown at bottom left and right, respectively.

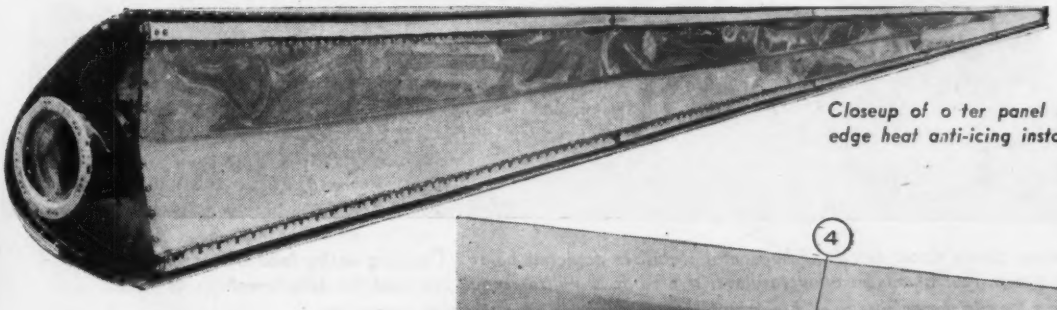


Above: Leading edge of right and left halves of wing center structure with hinged covers raised to expose plumbing. Four points of attachment for each engine are shown, two on front spar, two on after-mount projecting downward from wing lower surface. Details of outboard nacelle after-mount and upper attachment point are seen below.





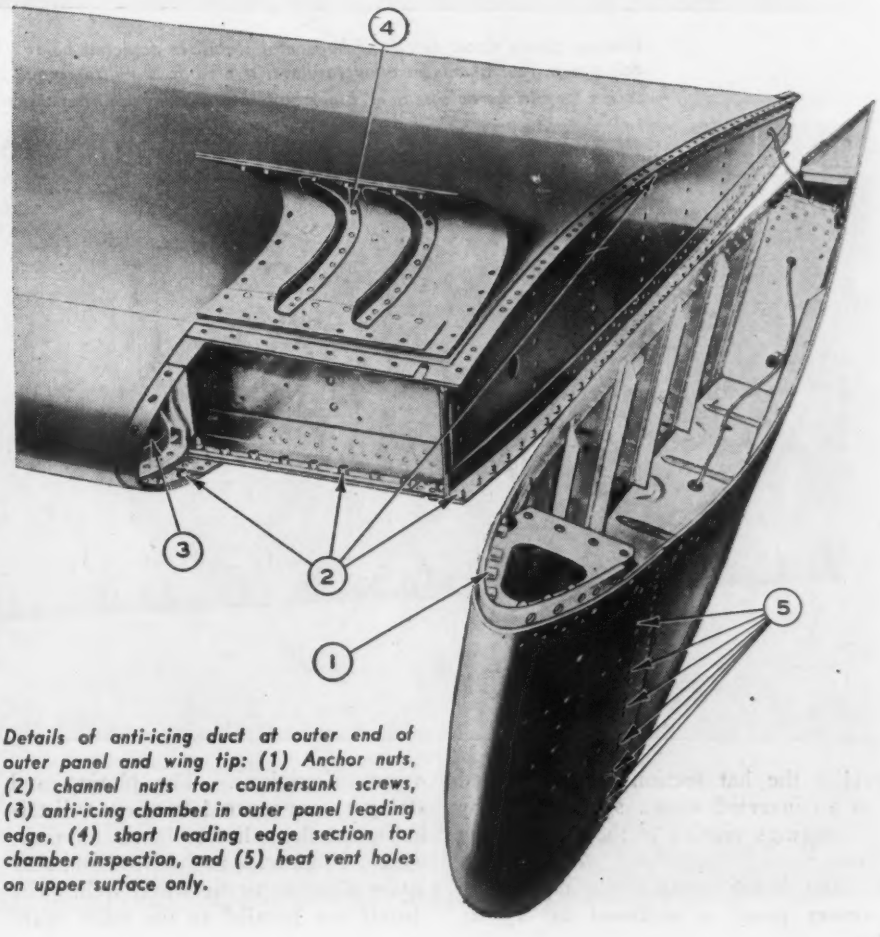
Wing leading edge showing hinged panel containing anti-icing duct. Connection (1) attaches to flange (2) fitted with asbestos cloth flexible coupling, and anti-icing duct (3) is closed at side (4).



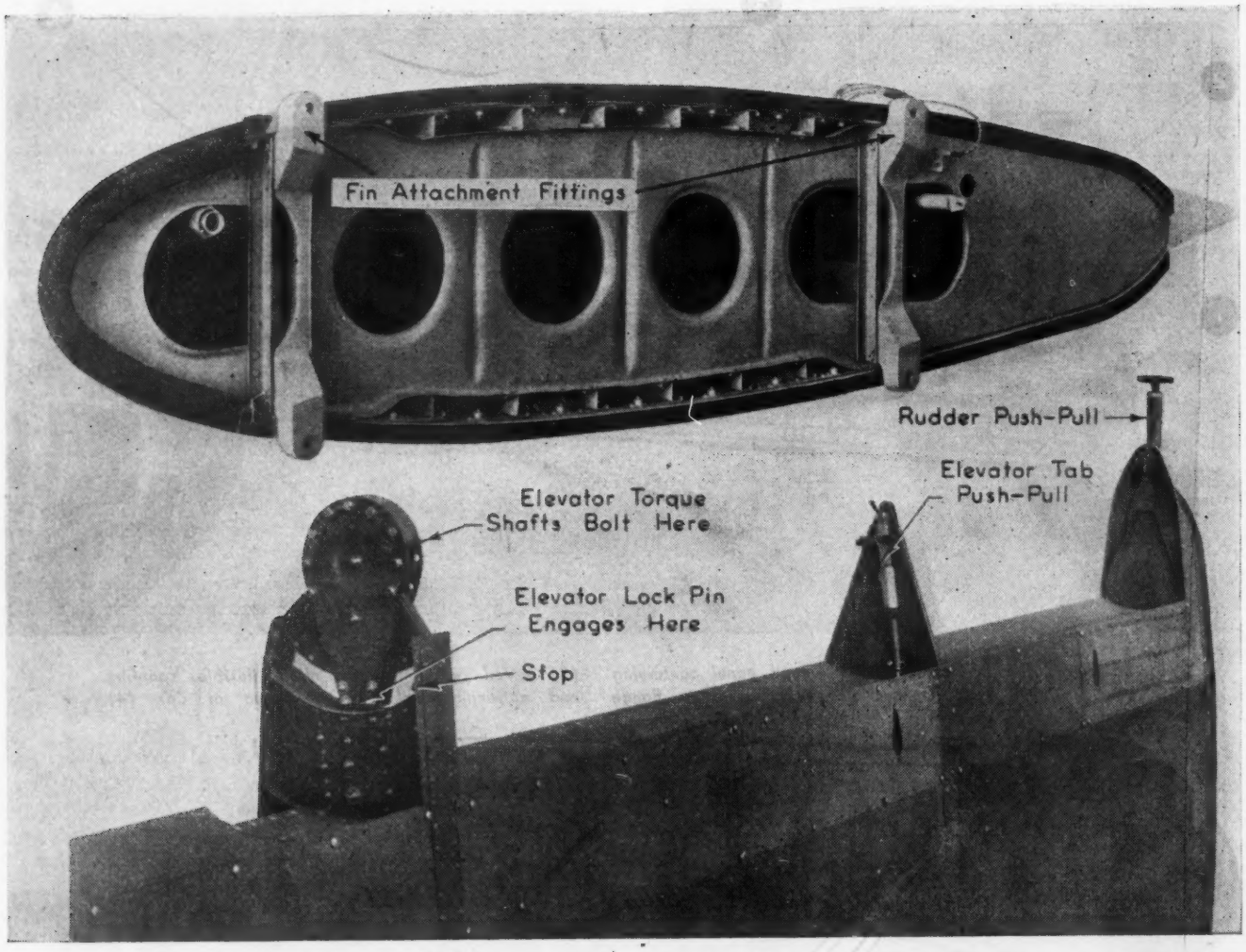
Closeup of outer panel leading edge heat anti-icing installation.

stringer combinations. There are 5 upper surface skin sections or panels on each side of the centerline. The upper skin at the root is .125 24ST Alclad for the forward 60 percent of the interspar distance, and .091 24ST Alclad for the aft 40 percent of the interspar distance. These skins extend spanwise 147 in.—to the end of the main fuel cell region. The remaining skins on the upper surface of the center section are divided into 3 strips. The forward strip is .114, the center strip .102, and the aft strip is .091 24ST Alclad. The gage reductions are made to save weight when strength requirements are reduced.

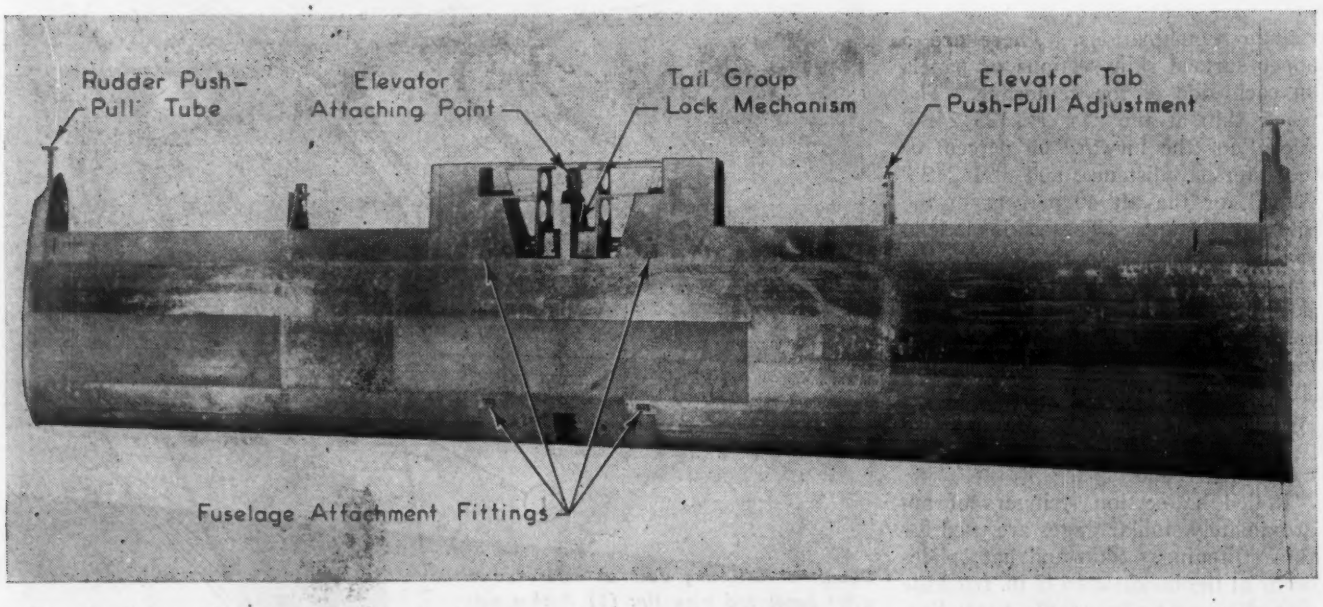
Rolled hat-section stringers of approximately similar gages are used for skin stiffening. Skin and hat splices occur at the bulkheads 147 in. from the centerline, and also at the centerline. Forged flanged strap fittings and splice plates connect both hat sections and skins. Outboard splice plates are buried, causing the splices to be flush. At the outer panel-to-center section



Details of anti-icing duct at outer end of outer panel and wing tip: (1) Anchor nuts, (2) channel nuts for countersunk screws, (3) anti-icing chamber in outer panel leading edge, (4) short leading edge section for chamber inspection, and (5) heat vent holes on upper surface only.



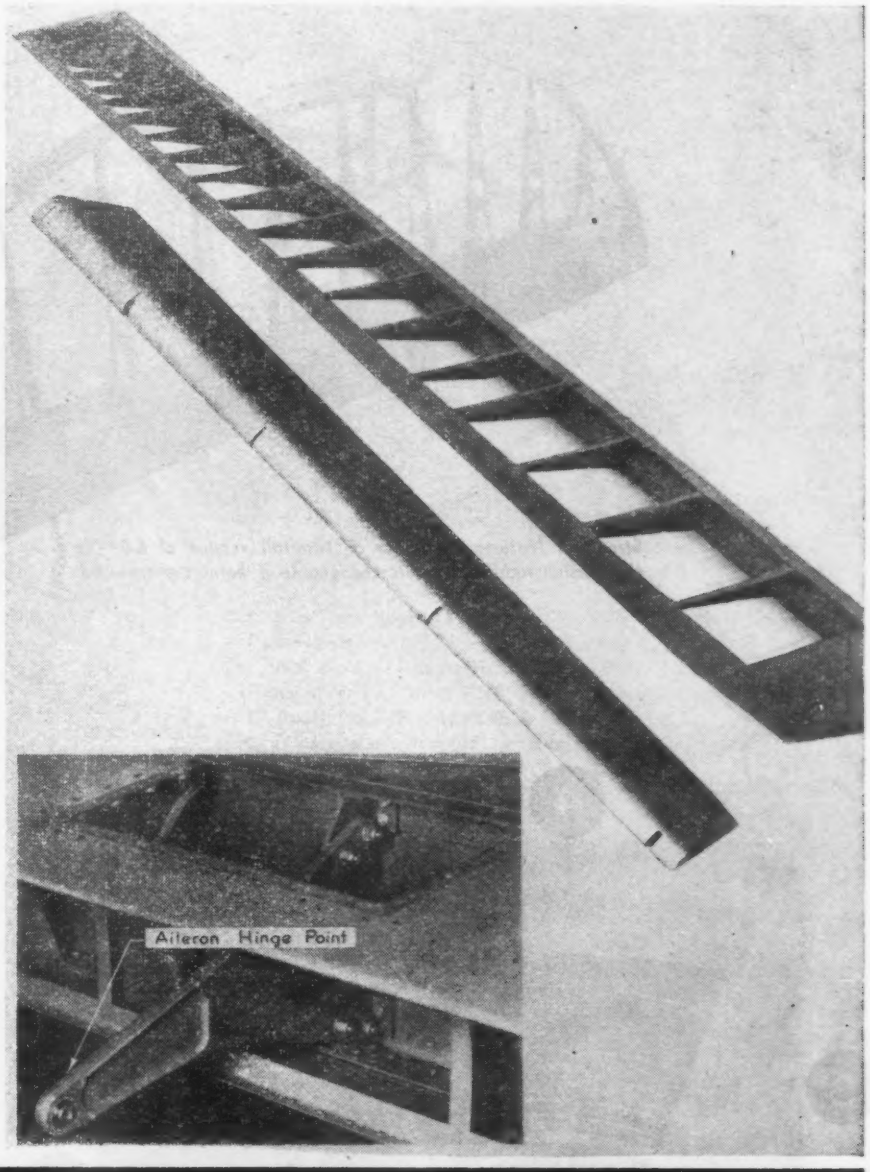
Closeup above shows details of horizontal stabilizer depicted below. Carrying entire load of tail group, four aluminum alloy forgings, riveted to stabilizer spars, are used for attachment to similar fittings on fuselage. Eight bolts are used in stabilizer-fuselage connection.



splice the hat sections are connected to an inverted flange splice angle by U-forgings riveted to the sides of the hats.

The lower surface plating of the center panel is stiffened by 1½ in. drawn Z-sections. The plating and stringers are tapered from even distribution at the splice to bands approximately 10 in. wide at the front and rear spars adjacent to the wheel well. The bands are parallel to the main spars, and the plating becomes continuous at the outboard end of the fuel tank. Material is concentrated by reinforcing sheets which reach a maximum thickness of approximately 9/16 in. at the wheel well. Spar flanges are jog-

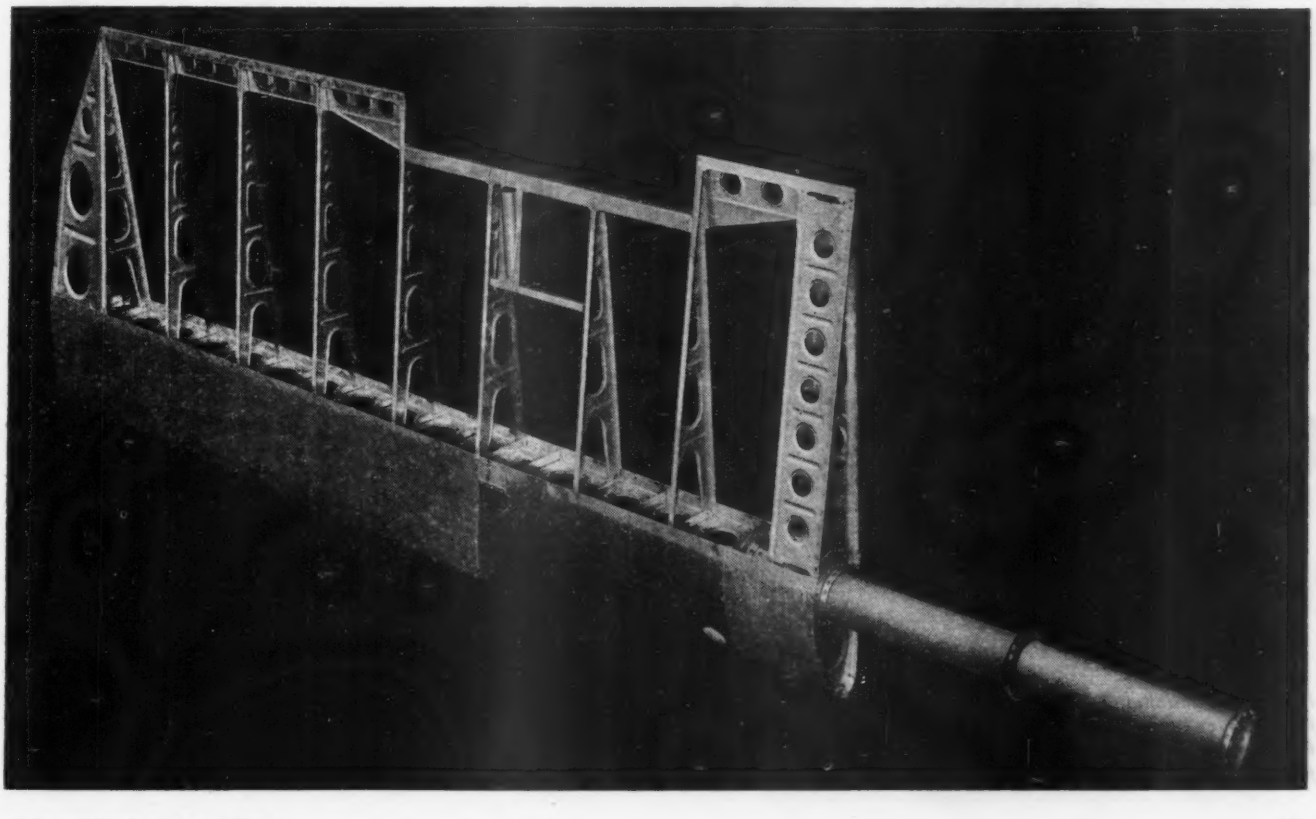
Seen here are structural features of aileron. Assembly has Alclad sheet leading edge and is hinged to wing outer panel at 5 points. Inset shows hinge attachment details.

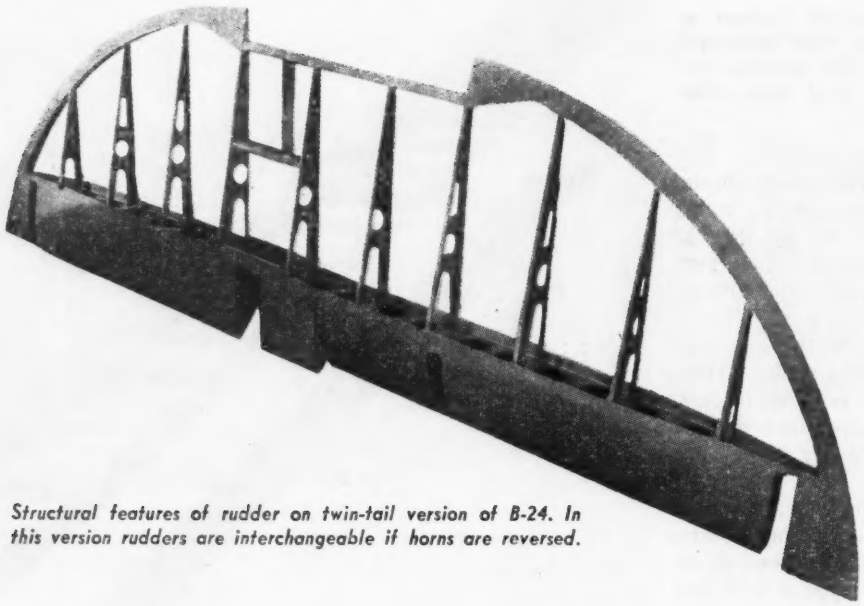


gled to accept the reinforcing sheets, and Z-stringers are spliced by fittings similar to those used for the hats at the main tank bulkheads. Stringers are attached to the wing splice attaching angles by forged T-fittings. Rivets on the upper surface of the interspar area are machine countersunk. When the required diameter is 7/16 in. or less, brazier-head rivets are used on the lower surface; all larger rivets are machine countersunk.

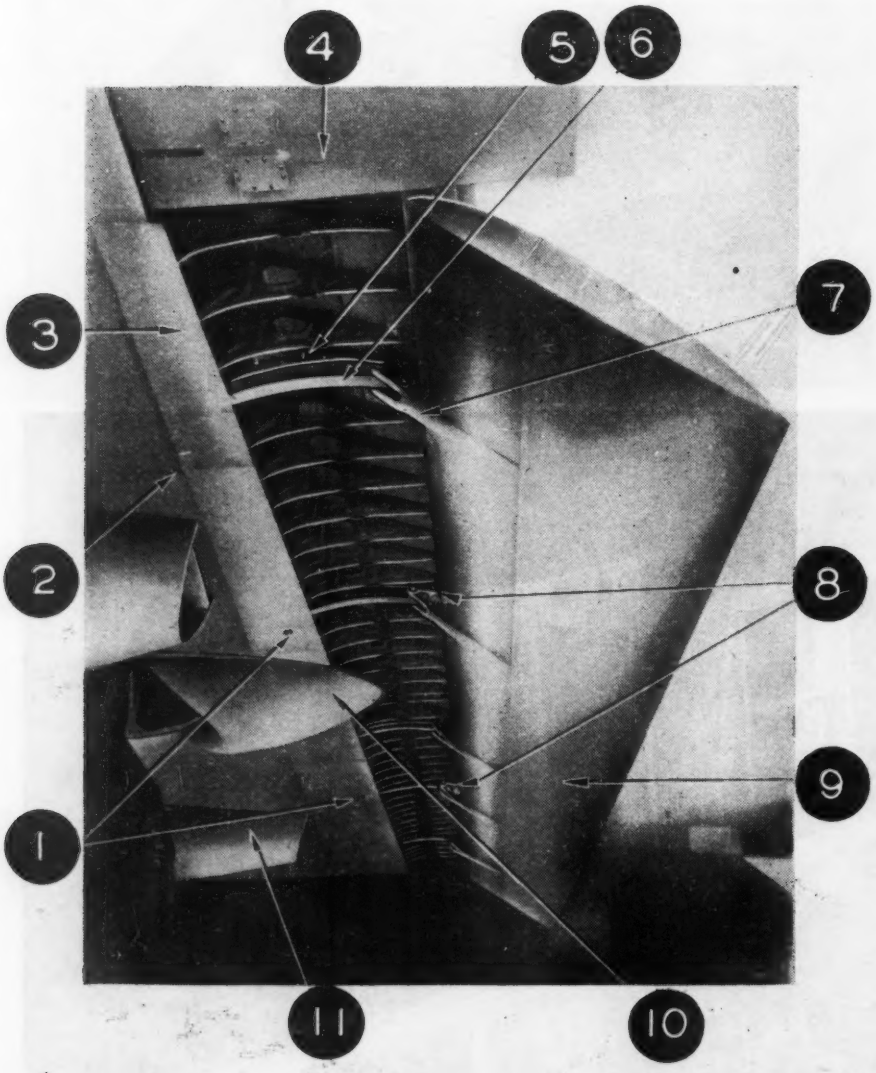
Center section interspar bulkheads are of three types—Wagner beam, truss, and pressed sheet—depending on what loads they carry, type of load, and whether access through them is required. There are 27 of them, 13 on each side and one at the center. The Wagner beam web is flat Alclad sheet and rolled angle flanges set back-to-back with the web on one side and stiffeners on the other. Trusses are Warren type with rolled channel chord members and interconnnecting diagonal rolled channels.

Details of elevator structure. Torque tubes of the two units are bolted together through control lock fitting mounted on stabilizer at centerline of plane. Hinge bearing supports are aluminum alloy forgings bolted to spars, and elevator movement is limited by stops.





Structural features of rudder on twin-tail version of B-24. In this version rudders are interchangeable if horns are reversed.



Fowler flap installation showing: (1) Up-stop inspection slots, (2) wing splice, (3) wing trailing edge, (4) aileron, (5) flap track support, (6) flap track, (7) flap carriage, (8) flap extending cable attachments, (9) flap, (10) wheel well fairing, and (11) engine nacelle fairing.

Main wing fittings include two hoist fittings which may be used in lifting the entire airplane in the weight-empty condition. They are attached to the bulkhead at the wing centerline.

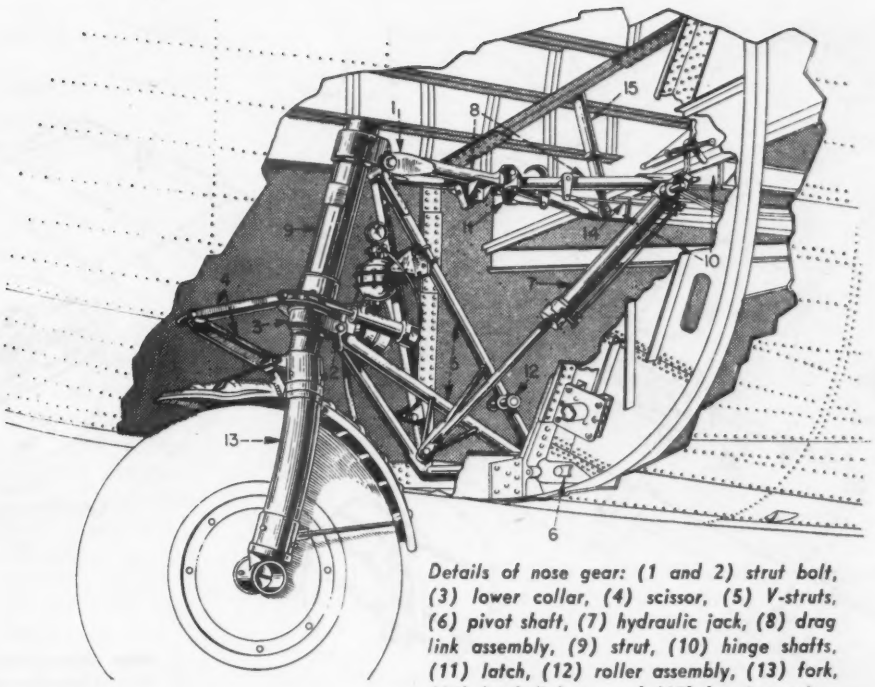
Landing gear fittings are simple forged flanged bosses, riveted to the auxiliary spars, also Wagner type with a web of flat Alclad sheet and rolled angle flanges set back-to-back, the web on one side and stiffeners on the other.

Upper engine mount fitting forgings are bolted and riveted directly to the upper surface of the front spar, while lower engine mount fittings are carried on a welded tubular sub-structure.

Fuel Tanks

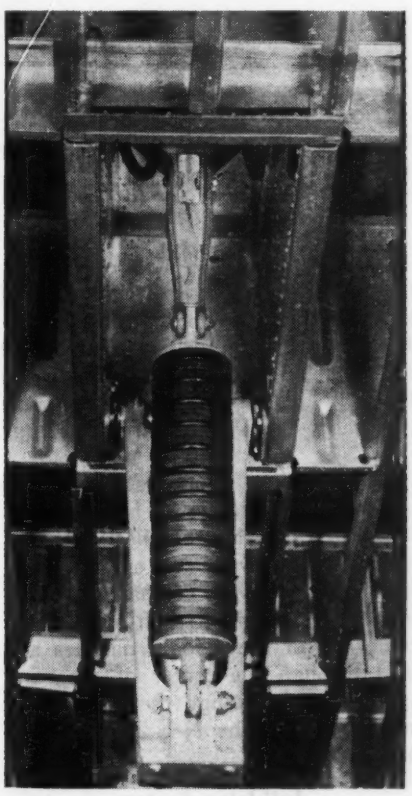
Two integral fuel tanks, each extending 147 in. from the wing centerline, were installed in the first Liberator wing. Sealing was accomplished by placing ¾ in. synthetic rubber gaskets in the tank seams. Little trouble was experienced with this type of construction, which had been previously developed and proved in the PBY's but military requirements made it necessary to replace the integral fuel tanks with self-sealing cells. Later, auxiliary cells were added in the area outboard from the wheel wells to the first outer panel bulkhead, providing still greater range.

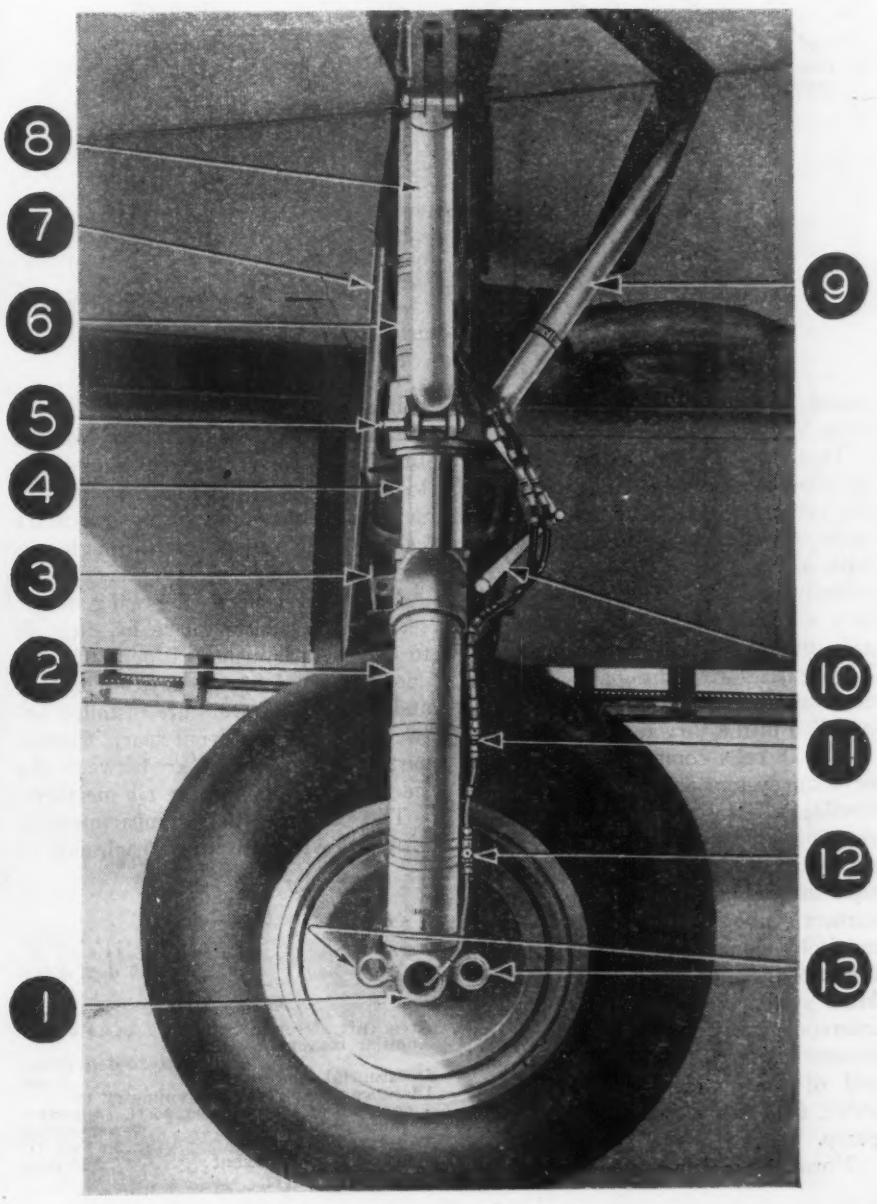
No basic design change was required to effect the fuel tank changes. A larger access door on the underside, removable members in two bulkheads adjacent to the ends of the tank region, and small access doors through which to reach fuel cell manifolds were provided and constituted the only wing changes required. Space for the addi-



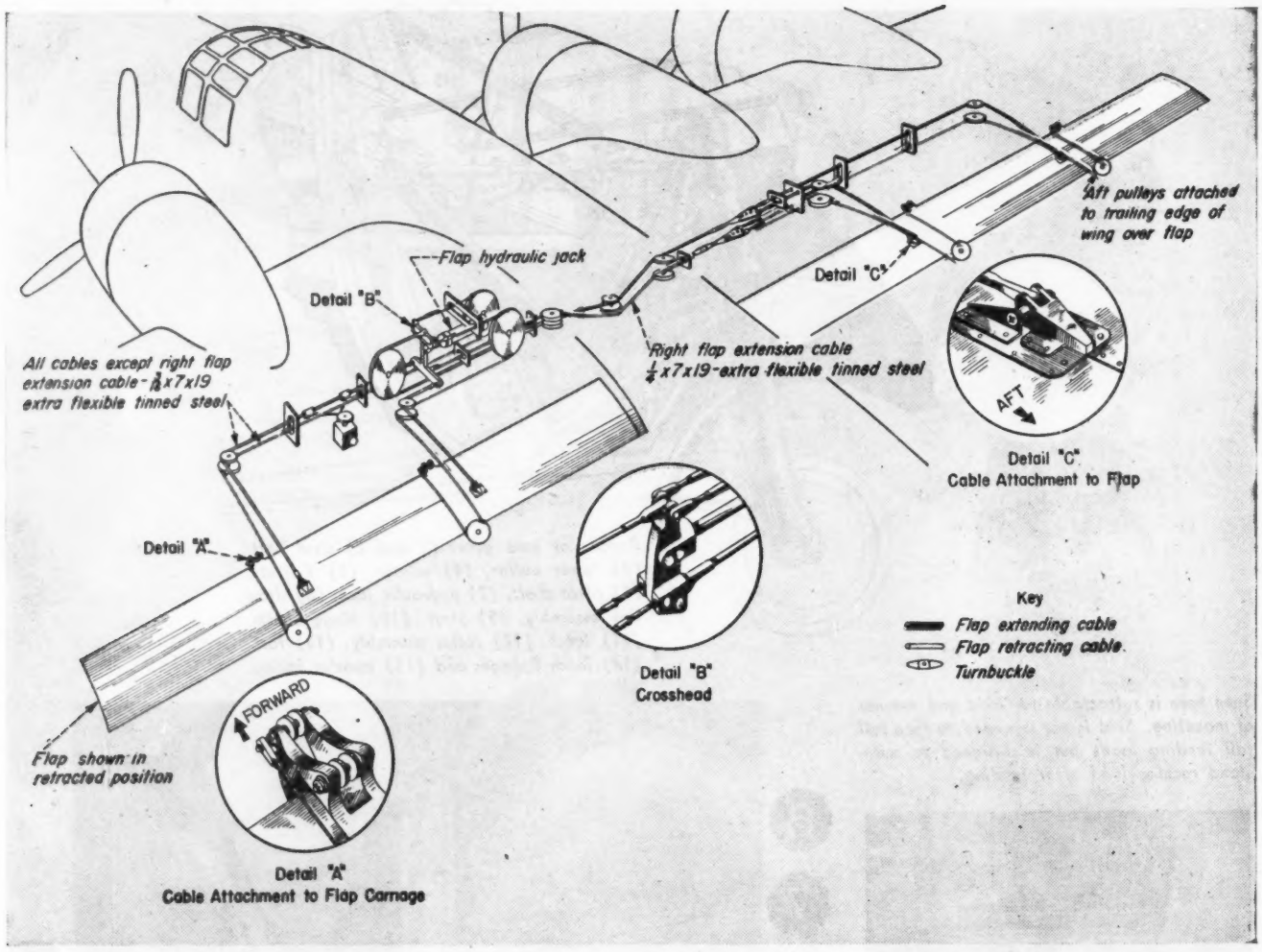
Details of nose gear: (1 and 2) strut bolt, (3) lower collar, (4) scissor, (5) V-struts, (6) pivot shaft, (7) hydraulic jack, (8) drag link assembly, (9) strut, (10) hinge shafts, (11) latch, (12) roller assembly, (13) fork, (14) latch linkage, and (15) booster spring.

Seen here is retractable tail skid and manner of mounting. Skid is not intended to take full tail landing loads but is designed to withstand rocking load after landing.





Outboard view of main landing gear: (1) Hollow axle, (2) fork tubes, (3) fairing link, (4) main oleo piston, (5) uplatch roller bolt, (6) oleo main cylinder, (7) fairing, (8) lower side brace, (9) drag brace, (10) scissors, (11) brake lines, (12) bleeder valve, and (13) towing lugs. Portion of turbosupercharger installation is seen to right of drag brace.


Aft pulleys attached to trailing edge of wing over flap
Flap hydraulic jack
Detail "B"
Detail "C"
All cables except right flap extension cable - 3/8 x 7x19 extra flexible tinned steel
Right flap extension cable 1/4 x 7x19 - extra flexible tinned steel
AFT
Detail "C" Cable Attachment to Flap
Detail "A"
Key
Flap extending cable
Flap retracting cable
Turnbuckle
Detail "B" Crosshead
FORWARD
Flap shown in retracted position
Detail "A" Cable Attachment to Flap Carriage

Details of flap cable installation.

tional tanks existed in the original wing and was merely utilized.

There are 18 self-sealing fuel cells installed in the wing, 9 on each side of the centerline. The 12 inboard cells make up the main fuel cell system, with a capacity of 2,343 gal., and 6 outboard cells comprise the two auxiliary systems with a capacity of 450 gal., giving a wing tank capacity of 2,793 gal. Two additional cells with a combined capacity of 790 gal. can be installed in the forward bomb bay.

The 18 cells comprising the normal or wing system are interconnected by flexible self-sealing manifolds to make six units of three cells each. Main system manifold connections are accessible through access doors in the lower surface of the wing. Auxiliary system manifold connections are reached from the inboard side of inboard nacelles. Main system units of three cells with interconnecting manifolds have a fuel booster pump located under the final cell of the unit, a shut-off selector valve, fuel strainer, and engine-driven pump.

Normally, fuel from one main unit is delivered independently to one engine (engine No. 1 from system No. 1). Fuel is transferred from the auxiliary to the main cells by the fuel transfer system. Connection of the auxiliary cells to the engines is through the crossfeed system.

Main fuel cells in the wing center section are held in place by their fit to the compartment. Where the cell does not completely occupy the full fore and aft depth, spacers are installed between the cell and front spar. Canvas curtains snap into place between the sides of the cells and the rib members.

The center section compartment is provided with a drain on each side of the centerline to discharge overboard any fuel which may leak from the cells. Flanges of these drains are located immediately aft of the two inboard booster pumps and are fitted with shut-off valves and overboard discharge lines.

The booster pump gland drains empty into these lines. The drain outlets lead through a bulkhead on each side of the catwalk and extend below the skin. The wing compartment vent lines are located on each side of the centerline of the inboard nacelles and pass through the center of the wing spar and out through the wing lower surface aft of the No. 2 and No. 3 nacelles.

Flap Data

Type	Fowler
Area, total	144.4 sq. ft.
Movement	0 to 40 deg. down

Aileron Data

Area (aft of hinge)	64.4 sq. ft.
Angular movement	20 deg. up, 20 deg. down
Differential motion	None
Distance from plane of symmetry to centroid of aileron area	40 ft. (approx.)
Balance	Aerodynamic
Tab area	3.64 sq. ft.
Angular tab movement	±10 deg.

Anti-Icing System

Leading edges of airfoils were originally designed for boot-type de-icers, but all current models of the airplane feature Convair's new exhaust-heat anti-icing system. This has made it necessary to provide ducts and double skins for conducting heated air to the leading edge surfaces. Edge strips, screwed to a ledge at the spar flange,

make it possible to attach the leading edges by means of self-locking nuts in gang channels.

Air heated by exhaust gases is piped through the leading edge and the other parts of the plane—pilots', radio operator's, tail gunner's, and bombardier's compartments, and the upper turret position. Other crew positions rely on electrically heated clothing for protection.

The system consists of a heat exchanger in the exhaust stack just ahead of the turbosupercharger, four in all, through which outside air is passed before flowing through ducts to the wing, empennage, and fuselage compartments. Ducting is aluminum sheet tubing covered with sheet asbestos, and averages 5 in. in diameter.

Each outer panel of the wing comprises an interspar structure with a removable leading edge and wing tip, a trailing edge structure forward of the ailerons, and a trailing edge structure forward of and over the flap. The spars are at 10 and 66.2 percent of the chord, and their design is similar to that of the center section spars. Interspar ribs are pressed aluminum alloy, and plate-stringer combinations complete the bending box.

Tail Group

Horizontal Tail Surfaces:
- Section ..... NACA 0015
- Area ..... 192 sq. ft.
- Span ..... 26 ft.
- Maximum chord ..... 7 ft. 8-3/16 in.
- Distance from design gross weight CG (assumed at 25% MAC to 1/3 maximum chord point) 33.40 ft.—approx. 3½ times MAC

Stabilizer:
- Area, including elevator balance 140.5 sq. ft.
- Normal setting (relative to longitudinal axis) ..... 2.5 deg.
- Angular movement ..... fixed

Elevator:
- Area, total ..... 67.1 sq. ft.
- Area aft of hinge line ..... 51.5 sq. ft.
- Angular movement 30 deg. up, 20 deg. down
- Balance ..... aerodynamic
- Tab area ..... 4.95 sq. ft.
- Tab angular movement ..... ±10 deg.

Vertical Tail Surfaces:
- Section ..... NACA 0007

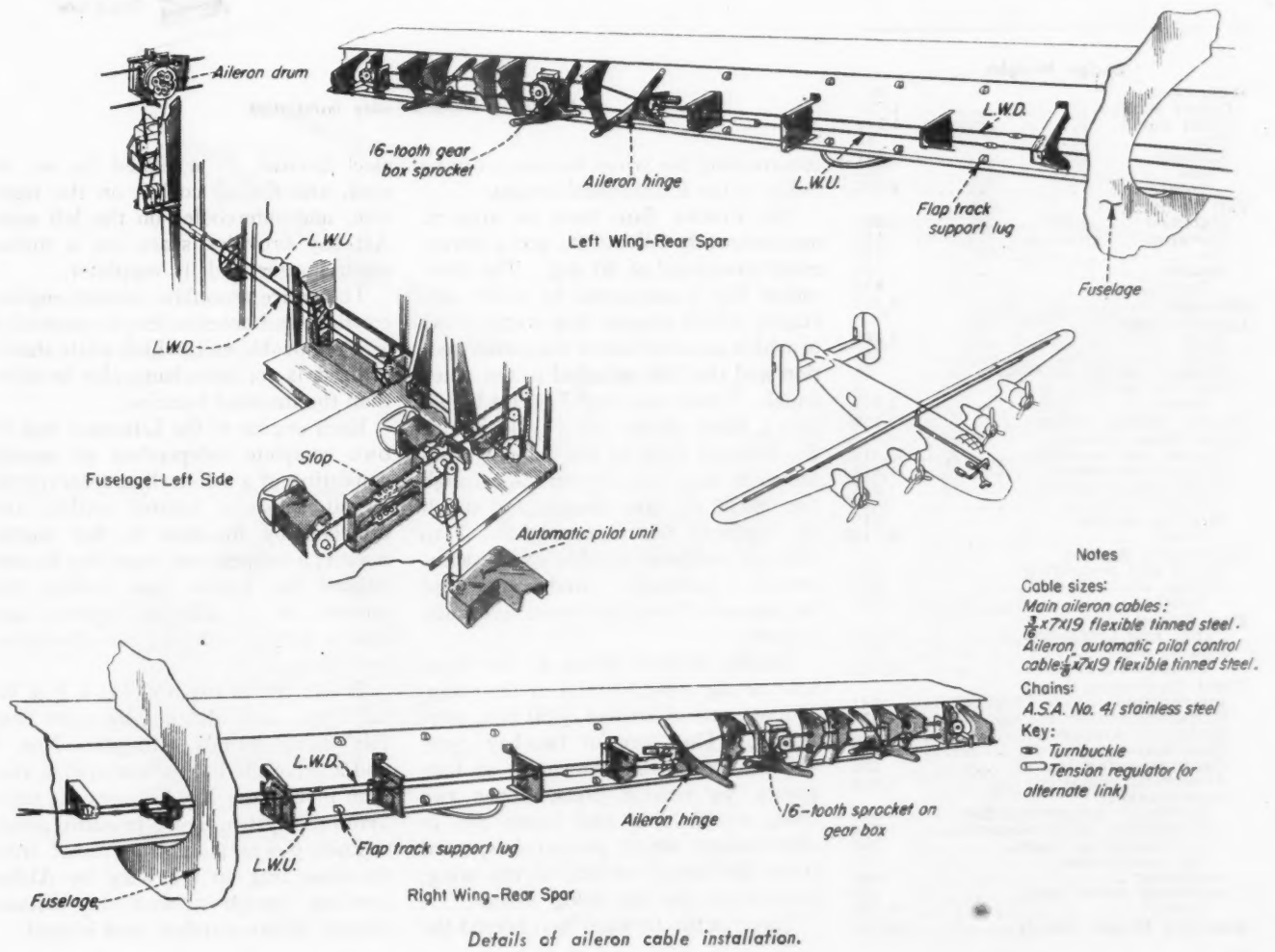
Fin:
- Area, total ..... 123 sq. ft.
- Normal setting ..... 0 deg.
- Angular movement ..... fixed

Rudder:
- Area, aft of hinge ..... 48.8 sq. ft.
- Angular movement ..... 20 deg. R, 20 deg. L
- Balance ..... aerodynamic
- Dynamic balance coefficient 0.014 (no greater)
- Tab area ..... 3.1 sq. ft.
- Tab angular movement ..... 10 deg. R, 10 deg. L

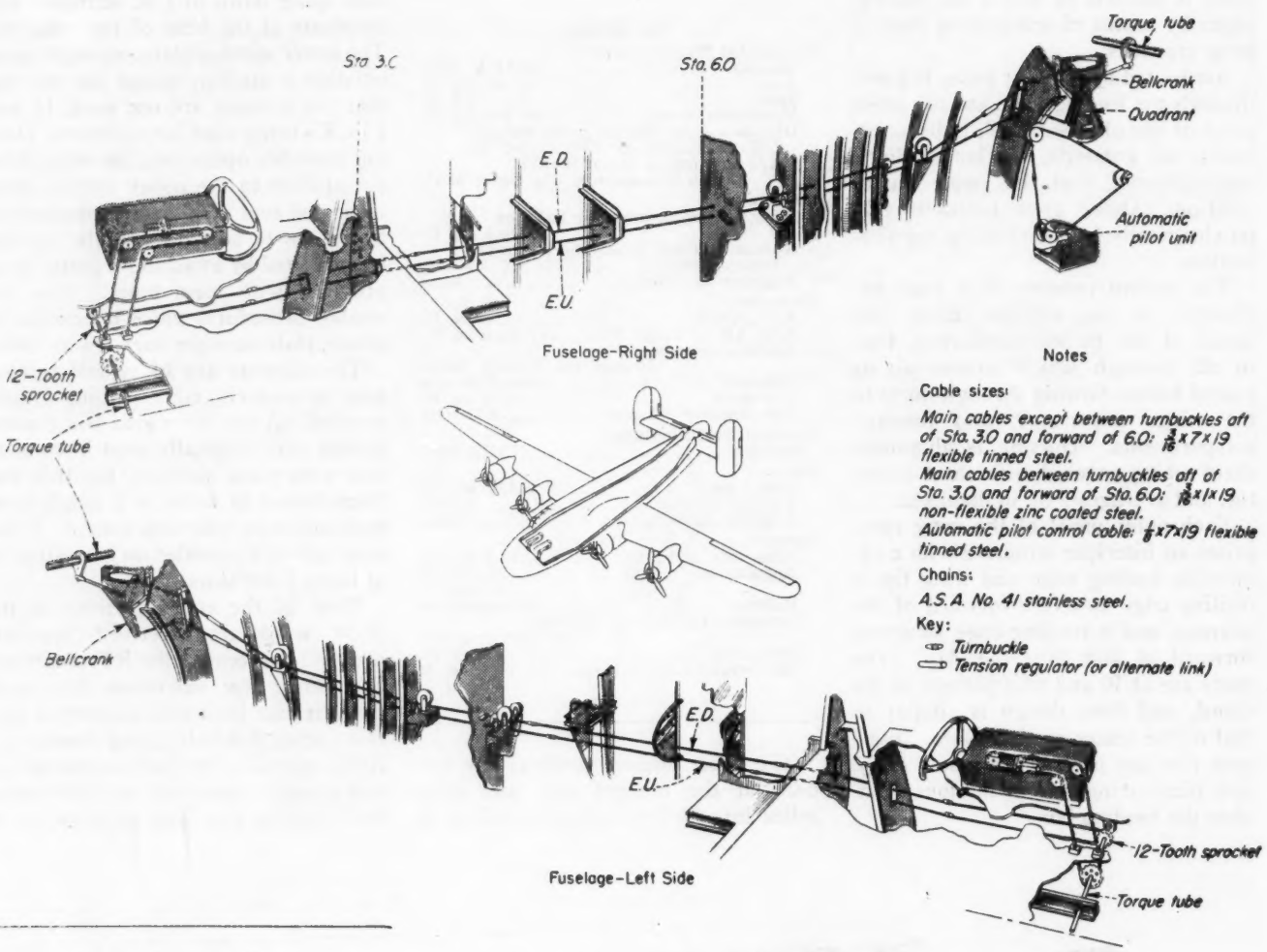
The upper surface employs hat sections at the inboard end, and these splice into 1½ in. Z-stringers which in turn splice down to 1 in. stringers and terminate at the base of the wing tip. The lower surface plates-stringer combination is similar, except for the fact that hat sections are not used, 1½ and 1 in. Z's being used for stiffeners. During assembly operations, the wing skins are applied to the upper surface first, front and rear strips are then attached to the lower surface, and the closure is completed by attaching a center strip provided with hand holes. New assembly procedures make it possible to attach plate-stringer surfaces as units.

The ailerons are of typical torque-box pressed-rib construction, fabric-covered. A two-horn gear box control system was originally used in connection with these surfaces, but this was discontinued in favor of a single-horn push-pull-tube bellcrank system. Trimming tabs are provided on both ailerons of latest Liberators.

Most of the rolled sections in the B-24 wing are stretched approximately 3½ percent to the RT condition; and, since few extrusions are used, Convair has been able to control section output simply by using sheet stock. Although rolled sections are not as dimensionally accurate as extrusions, little trouble has been experienced in



Details of aileron cable installation.



Details of elevator cable installation.

Design Weights

	lb.
Wing Group	
Center section	4,715
Outer panel	1,178
Tips	39
Ailerons	157
Flaps	252
Total	6,575
Tail Group	
Stabilizer	360
Elevator	136
Fin	216
Rudder	91
Total	830
Fuselage	3,334
Landing Gear	
Main	2,562
Nose	354
Bumper (wheel or skid)	28
Selector valve	3
Total	2,947
Engine Nacelle Group	1,529
Power Plant Group	
Engine (as installed)	6,032
Engine accessories	1,626
Power plant controls	336
Propellers (4)	1,804
Starting system	212
Total	13,243
Lubricating System	
Tanks and protection	380
Piping, etc.	325
Total	705
Fuel System	
Tanks and protection	2,248
Piping, etc.	280
Total	2,528
Fixed Equipment Group	
Instruments	141
Surface controls	630
Hydraulic system	455
Electrical	1,038
Communicating	585
Armament provisions	3,654
Furnishings:	
Personnel accommodations	163
Emergency accommodations	65
Provisions for flight	707
Air conditioning	112
Anti-icing	460
Auxiliary power unit	123
Total	8,131
Standard Weight Empty	36,562

constructing the wings because of flexibility of the fundamental design.

The Fowler flaps have an area of approximately 144 sq. ft., and a movement downward of 40 deg. The individual flap is supported by roller carriages, which engage five tracks, four of which are attached to the center section and the fifth attached to the outer panel. Tracks are steel I-beams bolted to a tubular planar truss. Clevises at the forward ends of the tubular truss attach to lugs which protrude through the spar at the spar flanges and attach to bulkhead chord members. Flap controls comprise a cable system actuated by a hydraulic cylinder energized by pressure from the main hydraulic system.

Engine mounts attach to the front spar of the inner section of the wing. Mounts are of welded 4130 c.m. steel tubing. They are of two-bay type, 45⅜ in. long. Attachment is at four points, by tension bolts, upper two being to the spar and lower two to after-mounts which project downward from the lower surface of the wing, because of the thin wing design.

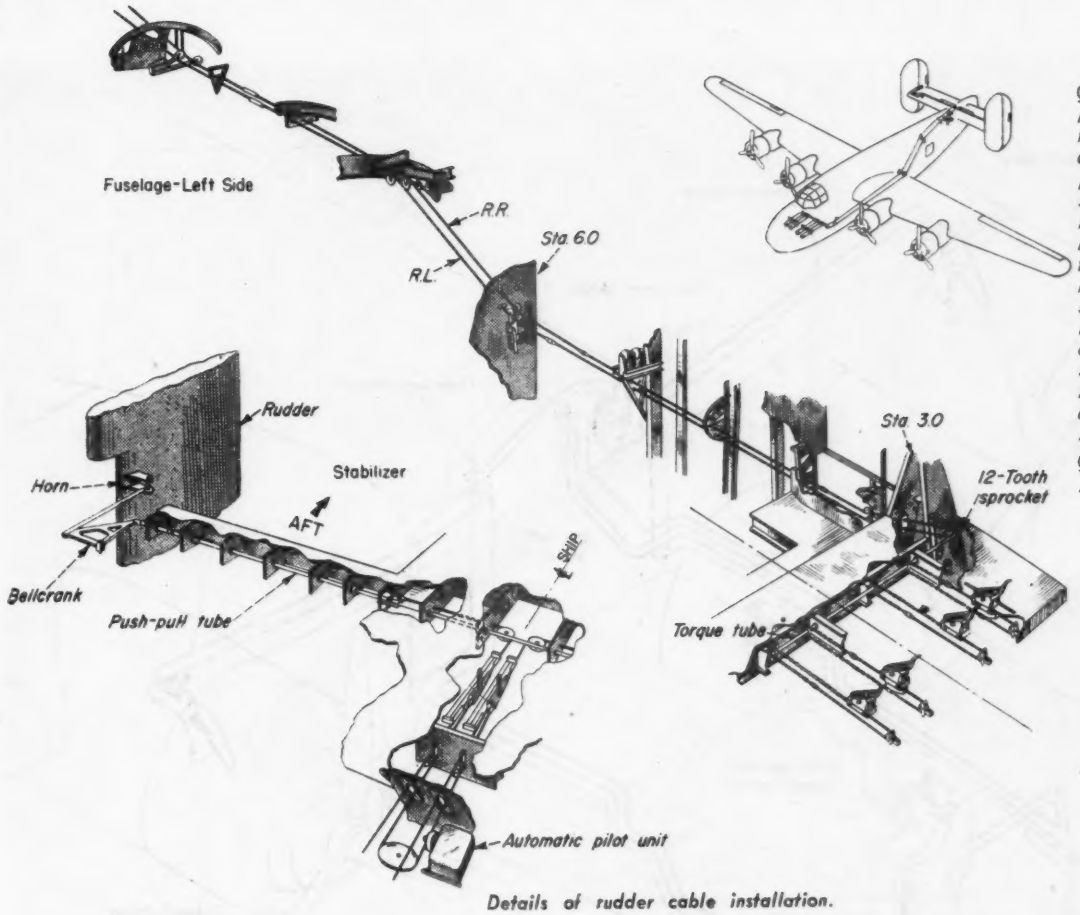
Space in the forward bay, behind the steel firewall, is occupied by an oil tank, and the oil cooler, on the right side, and intercooler on the left side. Aft bay provides space for a turbosupercharger and its regulator.

The entire assembly—mount, engine, cowling, and accessories—is assembled as a removable unit, which while standardized, is not interchangeable in other than the intended location.

Each engine of the Liberator has its own complete independent oil system consisting of a self-sealing reservoir of 42-gal. capacity located within and attached by brackets to the engine mount; a temperature regulator located behind the engine and within the mount; an oil dilution system; and drains, piping, controls, and oil separator.

Power plants are Model C-4, P & W, 1,200 hp., each attached by eight flexible shock mounts. Engines Nos. 1 and 2 drive the instrument system vacuum pumps and No. 3 drives the main hydraulic system hydro-pressure pump.

Each power plant is enclosed from the nose ring to the wing by Alclad cowling, except around the exhaust system, where stainless steel is used.



Notes

Cable sizes

Main cables except between turnbuckles aft of sta. 30 and forward of sta. 60: $\frac{3}{16}$ x7x19 flexible tinned steel.

Main cables between turnbuckles aft of sta. 30 and forward of sta. 60: $\frac{1}{16}$ x1x19 non-flexible zinc coated steel.

Rudder pedal run-around cable: $\frac{1}{32}$ x7x7 flexible tinned steel.

Automatic pilot control cable: $\frac{1}{8}$ x7x19 flexible tinned steel.

Chains

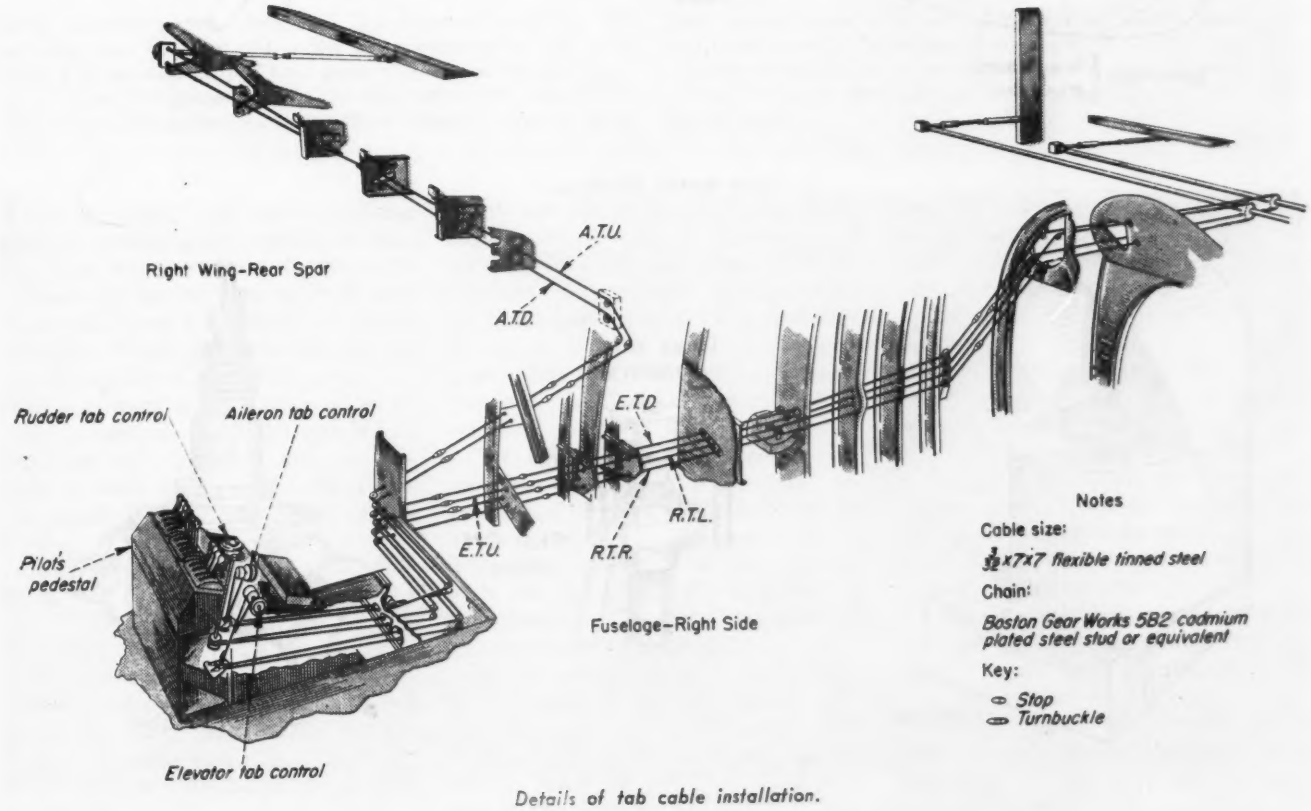
A.S.A. No. 41 stainless steel.

Key

Turnbuckle

Tension regulator (or alternate link)

Details of rudder cable installation.



Notes

Cable size:

$\frac{3}{32}$ x7x7 flexible tinned steel

Chain:

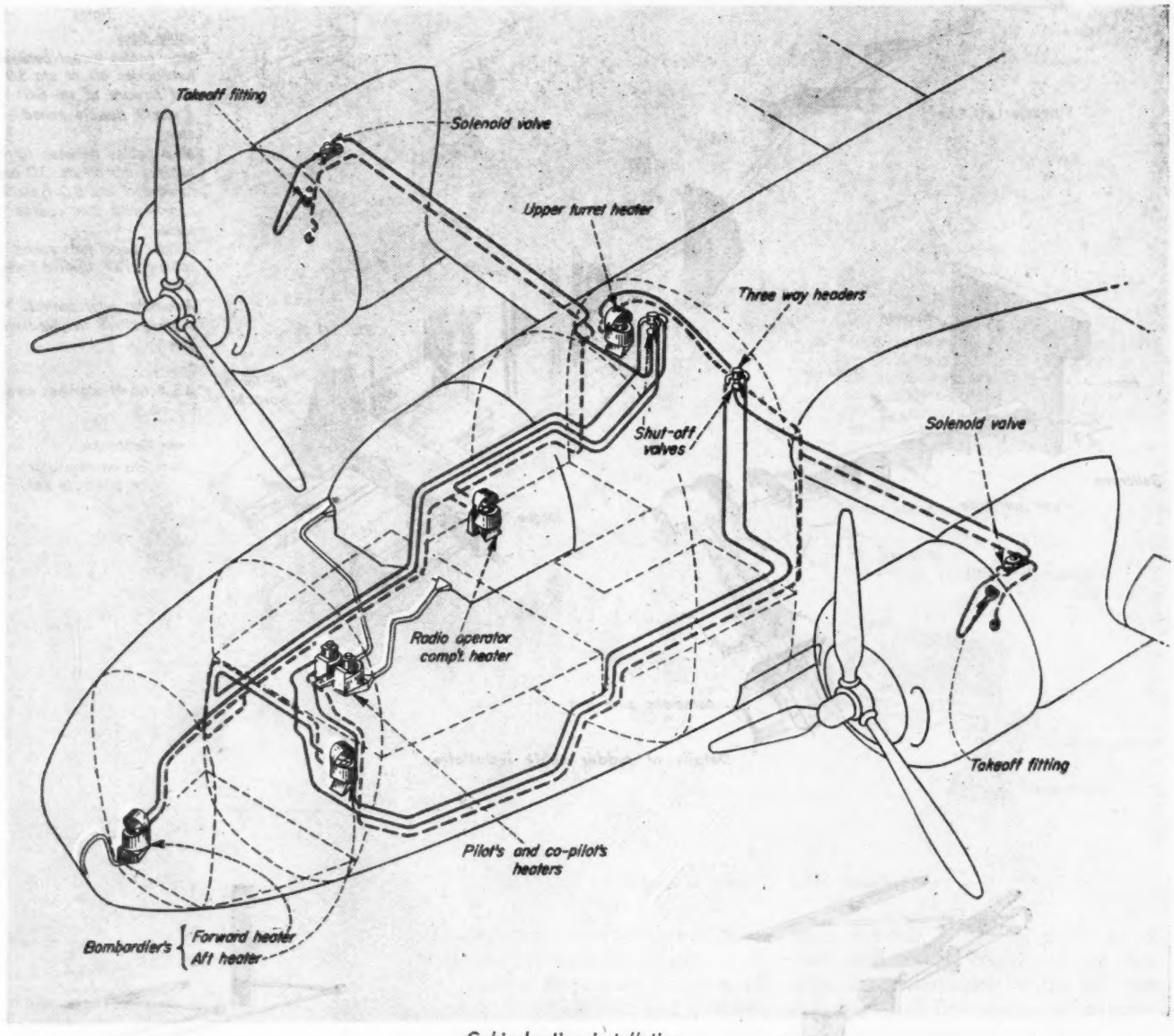
Boston Gear Works 582 cadmium plated steel stud or equivalent

Key:

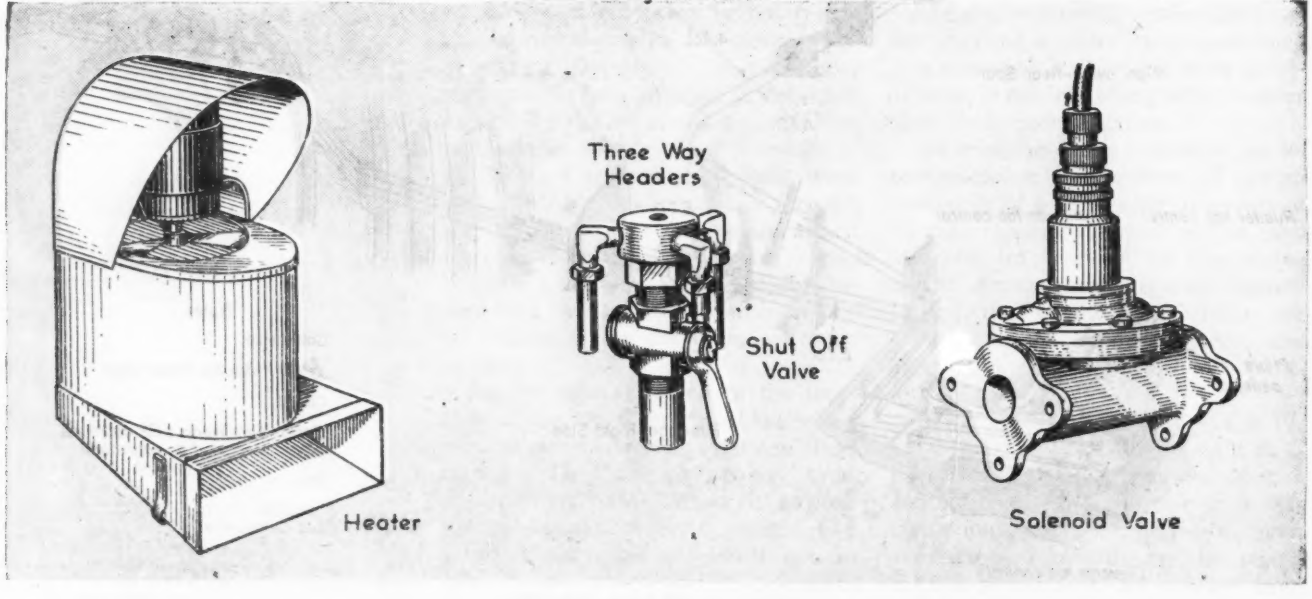
Stop

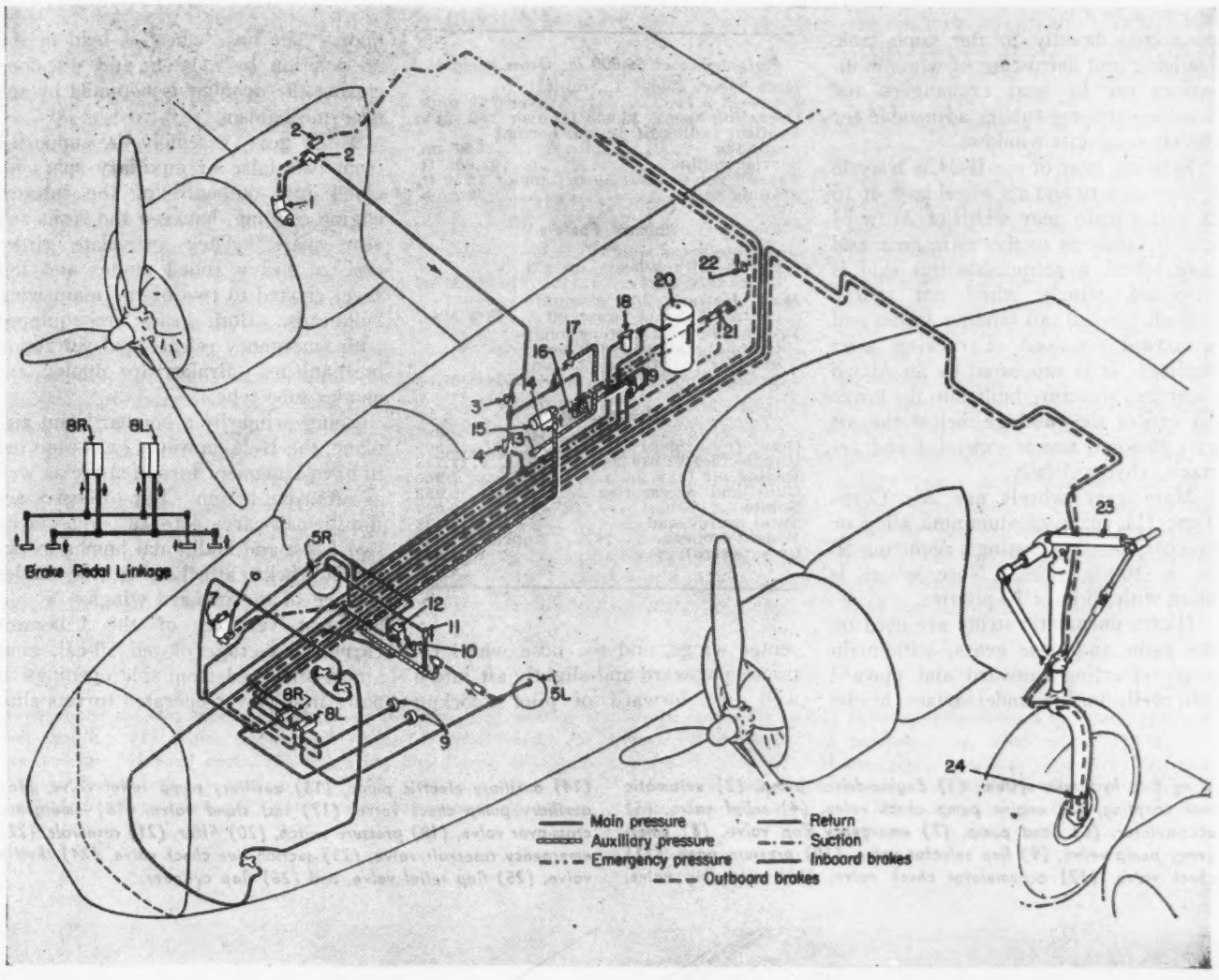
Turnbuckle

Details of tab cable installation.



Cabin heating installation.





Brake hydraulic system. Units are: (1) Engine-driven pump, (2) automatic seal coupling, (3) engine pump check valve, (4) relief valve, (5) accumulator, (6) hand pump, (7) flap valves, (8) brake control valve, (9) pressure gage, (10) check valve, (11) accumulator check valve, (12) unloading valves, (13) auxiliary pump relief valve, (14) auxiliary pump check valve, (15) auxiliary electric pump, (16) test stand valves, (17) emergency cross-over valve, (18) filter, (19) pressure switch, (20) reservoir, (21) emergency reservoir valve, (22) suction line check valve, (23) landing gear cylinder, and (24) brake bleeder valve.

The horizontal tail surfaces of the original design (twin rudder assembly) have NACA section No. 0015 and contain 192 sq. ft. Span is 26 ft. and maximum chord 7 ft. 8⅜ in. Distance from the design gross weight C. G., assumed at 25 percent MAC, to the one-third maximum chord point is 33.40 ft. which is approximately 3½ times MAC. Stabilizer area, including elevator balance, is 140.5 sq. ft. Its normal setting relative to the longitudinal axis is 2.5 deg.

The elevator has an area of 67.1 sq. ft. with 51.5 sq. ft. aft of the hinge line. Angular movement is 30 deg. up and 20 deg. down. The elevator is aerodynamically balanced and all spanwise elements are statically balanced about the hinge line. Tabs in the trailing edge have an area of 4.95 sq. ft. and are controlled by an irreversible mechanism.

Vertical tail surfaces have NACA section No. 0007 with a fin area of 123 sq. ft. and rudder area of 48.8 sq. ft. Rudders are aerodynamically balanced and fully balanced statically. Spanwise elements are statically balanced about the hinge line. Tabs have a total area of 3.1 sq. ft., and are equipped with irreversible controls. Rudder angular movement is 10 deg. right and left of center.

The new, single tail assembly, designed at the request of the AAF, required few changes in the original aft fuselage structures. The new stabilizer is designed to fit the old type fittings, with the dorsal and fin attaching to new structure. Front fin spar attaches to a new, built-up bulkhead.

All tail assembly control surfaces are of aluminum torque box and rib construction, covered with fabric. The stabilizer, constructed as a separate assembly, has a smooth sheet metal skin and is attached to the fuselage with only four fittings, to facilitate replacement. The entire tail assembly is mounted just enough forward of the tail gunner's compartment so that the trailing edge does not obscure the gunner's vision.

Propellers are Hamilton Standard Hydromatic three-bladed constant speed type, with quick feathering feature. Clearances are 37 in. to ground and 23½ in to fuselage. Normal distance to the plane of each propeller disk is 74⅛ in. at the centerline of the inboard engine. Controls are electrical and convenient to both pilot and copilot. Feathering pump oil is obtained from the main oil tank.

Propeller anti-icing is achieved with two electrically driven pumps installed below a 21-gal. tank located above the wing center section, between the life raft doors. One pump supplies pressure for both inboard propeller anti-icer rings and the other for the outboard propellers.

Anti-icing systems for pilots' and bombardier's windshield exteriors are

connected directly to the same tank. De-icing and defrosting of window interiors are by heat exchangers and flexible defroster tubing adjustable for direction against windows.

Landing gear of the B-24 is tricycle type with fore and aft wheel base of 16 ft. and a main gear width of 26 ft. 7½ in. In addition to the main gear and nose wheel, a retractable tail skid is provided, which, while not strong enough for full tail landing loads, will withstand the load of rocking after landing. It is supported by an Alclad sheet box structure built into the lower aft end of the fuselage, below the aft gun position, and is extended and retracted hydraulically.

Main gear wheels are Air Corps Type 111, made of aluminum alloy or magnesium alloy castings, requiring 56 in. x 16-ply tires. Nose wheel is fitted with 36 in. x 10-ply tire.

Hydro-pneumatic struts are used on the main and nose gears, with main gear retracting outward and upward into wells in the undersurface of the center wings, and the nose wheel retracting upward and slightly aft into a well just forward of pilot's cockpit floor. The nose wheel is held in the up position by a latch, and the door closing the opening is actuated by the gear mechanism.

Main gear assembly is supported from two false or auxiliary spars located just outboard of the inboard engine cowling, between the front and rear spars. They are plate girder type of heavy rolled angles and flat sheet riveted to two of the main wing bulkheads. Both gears are equipped with emergency release and retraction mechanisms. Brakes are duplex expander tube type.

Being primarily a bombardment airplane, the B-24, however, was required to have armament for defensive as well as offensive action. For offensive action, it can carry 4 to 22 bombs in its two bays, and additional bombs in external racks attached to the under surface of the inboard wings.

Latest versions of the Liberator carry an average of ten 50-cal. guns aimed and fired from side openings in pairs in 4 power-operated turrets situ-

Performance at 56,000 lb. Gross Weight

High speed, 25,000 ft., military power	over 294 mph.
Operating speed, 25,000 ft.	over 230 mph.
Tactical radius of action, normal mission	750 mi.
Service ceiling	32,000 ft.
Takeoff run to clear 50 ft.	under 3,950 ft.
Stalling speed	79 mph.

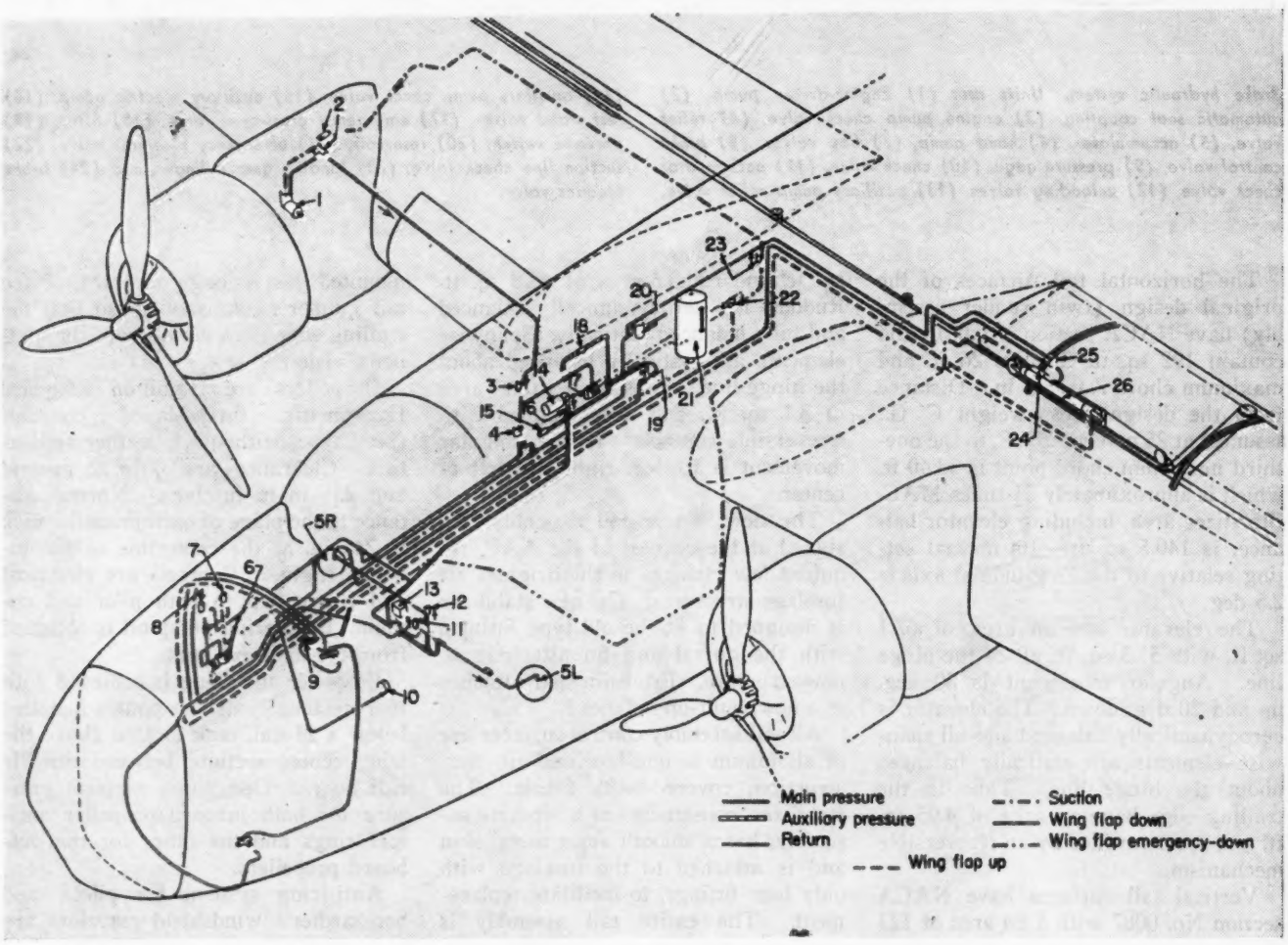
Balance Factors

Alternate gross weight CG location with wheels up aft of leading edge	30.9% MAC
Most forward for adequate control, landing power off	23% MAC
Most aft for satisfactory longitudional stability with power and for satisfactory ground handling	34% MAC

Useful Load

	lb.
Crew (nine men)	2,000
Engine fuel (2,120 gal.)	12,718
Engine oil (128 gal.)	960
Guns and accessories	1,953
Bombs	2,007
Total useful load	over 19,438
Weight empty	approx. 36,652
Gross weight	over 56,000

Wing flap hydraulic system: (1) Engine-driven pump, (2) automatic seal coupling, (3) engine pump check valve, (4) relief valve, (5) accumulator, (6) hand pump, (7) emergency flap valve, (8) emergency pump valve, (9) flap selector valve, (10) pressure gage, (11) check valve, (12) accumulator check valve, (13) unloading valve, (14) auxiliary electric pump, (15) auxiliary pump relief valve, (16) auxiliary pump check valve, (17) test stand valve, (18) emergency cross-over valve, (19) pressure switch, (20) filter, (21) reservoir, (22) emergency reservoir valve, (23) suction line check valve, (24) shuttle valve, (25) flap relief valve, and (26) flap cylinder.



ated in the nose, the top, belly, and tail. Remaining 2 guns are flexibly mounted, so that they can be manually aimed and fired from side waist enclosure in aft part of fuselage. Armor plate protects areas around all crew members and vital equipment.

Main hydraulic system of the Liberator operates the wing flaps, bomb bay doors, wheel brakes, and landing gear. Rear gunner's turret is hydraulically powered by a separate system mounted on the right side of the fuselage adjacent to the tail turret. The system is a combination of the better features of the direct pressure and open center systems, and is termed an open center pressure and return unit.

The B-24 electrical system has three main sources of energy—batteries, generators, and a 2 kw. auxiliary power unit located on the left side of the fuselage just ahead of the bomb bay and below the flight deck. The units connect to a common distribution system which covers the entire plane. The d.c. to a.c. inverters supply energy to special equipment requiring alternating current.

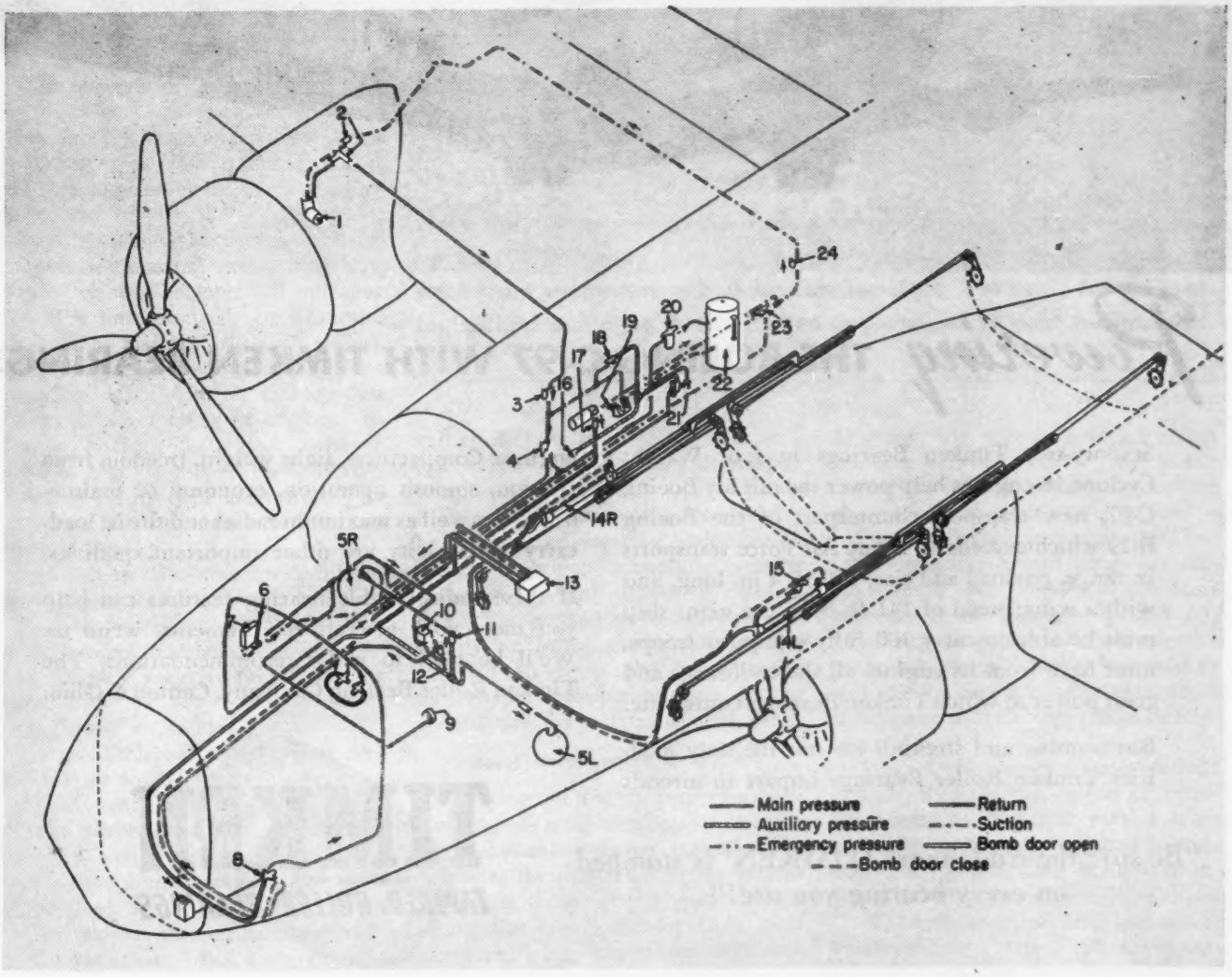
Radio, interphone, and directional radio equipment aboard the B-24 derive power from the 24 v. d.c. supply of the main power system. The interphone consists of an amplifier, dynamotor, jack box, and one throat microphone and microphone-amplifying equipment for each crew station. Each throat microphone is equipped with switch cord or a push-to-talk switch.

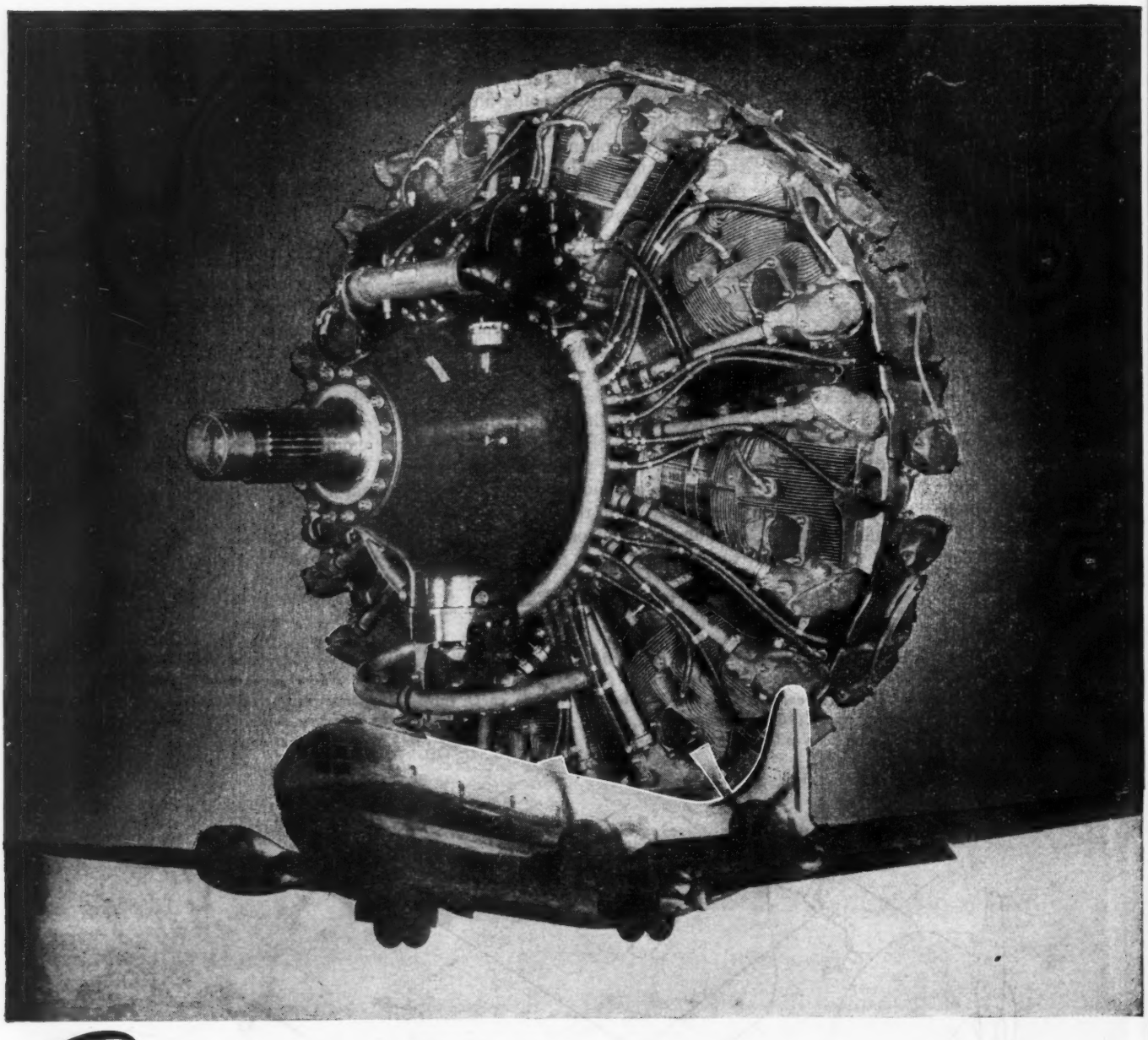
The command radio consisting of two transmitters and three receivers, is mounted above the wing center section just aft of the life rafts. Modulator unit, dynamotor modulator unit, and dynamotor are mounted aft of the compass receiver, on the rack for the radar equipment. Liaison radio includes one transmitter located on the flight deck, under the radio operator's table, and a receiver on the table. Radio compass is located over the wing center section on the right side, and the marker beacon is located in the bomb bay.

Capacity of the oxygen system, originally provided by 5 fixed-position bottles in the upper aft section of outboard engine mounts, has been increased to 26 bottles of 350-psi. type, located at strategic points. Pressure scale, translated in terms of altitude is controlled by the user and maintained at a setting 5,000 ft. higher than the indicated altitude.

Although, like other U. S. combat aircraft, the B-24 Liberator has frequently been subject to increases in empty weight because of need for additional equipment and protection dictated by the ever-shifting exigencies of war, it has continued to deliver larger bomb loads, farther and faster. That was its designed intent.

Bomb door hydraulic system: (1) Engine-driven pump, (2) automatic seal coupling, (3) engine pump check valve, (4) relief valve, (5) accumulator, (6) hand pump, (7) emergency flap valves, (8) bomb door selector valve, (9) pressure gage, (10) unloading valve, (11) accumulator check valve, (12) check valve, (13) bomb door emergency and utility control valve, (14) bomb door cylinder, (15) bomb door relief valve, (16) auxiliary pump relief valve, (17) auxiliary pump check valve, (18) emergency cross-over valve, (19) test stand valve, (20) filter, (21) pressure switch, (22) reservoir, (23) emergency reservoir valve, and (24) suction line check valve.





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TAPERED ROLLER BEARINGS

DESIGNING TOMORROW'S PERSONAL PLANE

PART II

By RALPH H. UPSON, *Consulting Engineer*

Here the author, one of America's foremost design consultants, sets up the "score card" for five possible types of craft and analyzes each from performance and cost standpoints. The basis for estimating weight and drag is established and applied to each design type.

WE HAVE SET UP a vision (Part I, June AVIATION) of the kind of performance that ought to be possible for a lightplane, with nothing more than a clean-up of unnecessary drag. This process resulted in approximately doubling the speed, the carrying capacity, and the range of a typical prewar design.

The problem that confronts us now is not merely to "try and get it," but to pick the most feasible path of approach, with other desirable features in mind, using fairly conservative estimates and requirements.

The question of how to arrange the basic elements—fuselage, wing, powerplant, landing gear, and tail—will first be considered from a standpoint of weight and drag for the particular purpose intended.

For a preliminary comparison, it will be assumed that we are dealing with single-engine enclosed landplanes, avoiding unrecognized, controversial, or bizarre features, such as tailless, tail-first, and folding-wing types, boundary layer control, laminar-flow contours, novel types of engines, extension shafts, etc. Flaps, however, are now considered well enough established to justify their use for any type of plane. We come, then, to five main comparisons:

1. High vs. low-wing (with biplane as a supplemental variant).
2. Strut-braced vs. cantilever wing.
3. Fixed vs. retractable landing gear.
4. Tricycle vs. conventional landing gear.
5. Pusher vs. tractor.

For mathematical completeness, each comparison would have to be made for each different possible combination of all the alternatives. The number of different major arrangements is the same as the number of heads-tails possibilities of five pennies, which is 2^5, or 32, without intermediate and incidental variations. But some of these can be literally laughed off, such as a low-wing, externally braced pusher with retractable gear.

Other combinations can be restricted by rational engineering judgment to an extent which apparently permits reducing the total number of cases to five. The method of analysis will be clearly set forth, so that anyone not satisfied can set up other combinations or try out possible changes in the weight and drag of component items.

Basic Arrangement of Parts

In laying out a comparative series of designs, we must distinguish between modifications or design features incidental to the particular comparison at issue, and those arbitrarily introduced by habit or fancy. For example, most cantilever wings are of stiff-skin construction, not primarily because they are cantilever but because they usually have been in a class of wing loading that well justifies such construction.

For similarily irrelevant reasons, most externally braced wings are fabric covered; but it would be obviously misleading to compare a stiff-skin cantilever wing with a fabric covered, externally braced wing. It would be as logical to throw in other extraneous differences such as bigger flaps or folding wings.

Taper is of course a more definite consideration in the design of cantilever wings. Not that such a wing must be necessarily tapered (probably the lightest wing in service today is fabric covered, untapered cantilever); but for equal drag and structural efficiency, taper still saves ap-

preciable weight. On the other hand, taper introduces an unresolved cost difference that complicates consideration of other features; hence these comparisons will be made uniformly on the basis of the untapered wing form.

External struts are assumed confined to the high wing, because of their unfavorable interference and structural difficulty above a low wing. For equal wing loading, the beam or lift resisting structure is the only significant

Pete Pilot: "Kinda slow with that fixed gear, isn't it?"
Ernie Engineer: "A little, but you wanted a lower priced plane."

source of weight difference per sq. ft. between the externally and internally braced wing; and, as will be shown, this increment of weight in a lightplane is relatively small, especially for the assumed one-piece wing.

Consideration of the pusher is here limited to the high-wing type because of the serious problem of wing-fuselage interference in a low-wing pusher; and because vision, the pusher's principal advantage, can be best obtained with a high-wing.

Although a major advantage of a low-wing is in connection with retractable wheels, a cantilever low-wing is also of advantage with fixed landing gear and is therefore included. High-wing designs, however, will be considered only with fixed gear, because of the relative unsuitability of a high-wing to landing gear retraction.

There appears no need to compare the tricycle with conventional landing gear for the more than one wing and power plant arrangement, since the weight and drag difference should run about the same for all. Conventional landing gear is assumed for the high-wing tractor and tricycle gear for the pusher as the most logical arrangements for these two types.

Because of the interest in immediate possibilities, the present comparisons will be based on somewhat less extreme demand as to performance, and more conervative design conditions, than formed the basis for the general possibilities developed in the preceding article. It is assumed that either takeoff or cruising power may be the criterion of engine size. For the former condition, power loading will be held constant at a value which will not only limit the takeoff distance but also satisfy any reasonable requirements for climb and ceiling. In everything except the percentage of full power used for cruising, this constant power loading favors a plane of high drag but low weight by making the rated power independent of cruising speed.

The Line-Up

Thus the following actual participants in the contest for design superiority are now simply set down and described, along with the rules of the game.

These are the planes:

Type A—Cantilever, low-wing tractor; retractable tricycle landing gear.

Type B—Cantilever, low-wing tractor; retractable conventional landing gear.

Type C—Cantilever, low-wing tractor; fixed conventional landing gear.

Type D—Braced, high-wing tractor; fixed conventional landing gear.

Type E—Braced high-wing pusher; fixed tricycle landing gear.

The principal comparisons are then: D vs. E; C vs. D; B vs. C; and A vs. B.

These are conditions that all must meet:

1. Carry 575 lb. (including 3 persons) of useful load, less fuel and oil.

2. Maintain a wing loading of 10 lb. per sq.ft. which, with good flaps (Max. C_L = 2.0) will permit landing at under 45 mph.; this item reduced 4 percent for pusher to allow for forward center-of-gravity position at full load.

3. Maximum rated power loading: 17 lb. hp., which in combination with the wing loading will control the sea level takeoff distance to safely under 1,000 ft. over a 50-ft. obstacle, even with a fixed-pitch propeller.

4. Ultimate range: 600 air miles (fictitious, assuming constant fuel consumption of 0.52 lb. per hp.-hr. with no allowance for climb or variation of fuel consumption) a true speed of 120 mph. at 7,000 ft. Actual range = 500 ± 50 air miles.

5. All wings rectangular; aspect ratio 6; thickness ratio: cantilever 0.15, braced 0.12; metal structure, fabric covered or equivalent in weight.

The appended data on drag and weight are based on the references given, subject to the following qualifications:

The engine weight, including starter, is about midway between present average and minimum weights. Estimated indirect additions to fuselage and tail weights, due to the power plant, are considered as power plant weight. Because of the variable proportion of cruising to rated power, fuel and tank weights are made functions of cruising power; but the balance of the power plant weight remains a function of rated power.

Wing weight includes an increment for the contribution of the tail, or rather that part of the tail which is estimated to depend directly on the wing. As in the case of an all-metal wing, the weight is divided between two terms, the first being the surface weight (constant per unit area for equal wing loading), and the second the beam structure, incidental weights being divided between the two.

Due to the fabric skin, the first-term coefficient is substantially reduced in comparison with all-metal wings, but the second-term coefficient is a little increased. Also the assumed constant aspect ratio, with the relatively small magnitude of the second term, permit combining both into a single term for this particular comparison, with only a difference in the coefficient to distinguish between the weight of the cantilever and externally braced wings.

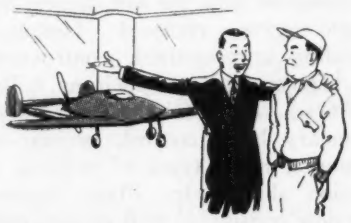
As may be expected, the landing gear weight is a function of the type, and the weight it has to carry.

Power plant drag, largely chargeable to cooling, is estimated as a fixed proportion of the cruising power. This procedure implies a well-cowled engine with some means of adjusting the quantity of cooling air.

Wing drag, in similar manner to the weight, includes a tail increment; and it also allows for fuselage interference, usually negative because of the overlapping surface.

For the landing gear, the residual drag of a retracted nose wheel is assumed equal to that of a conventional (exposed) tail wheel.

Propeller efficiency values are estimated as being possible for the fixed-pitch wood type, assuming average



Salesman: ". . . and retractable landing gear too!"
Pete Pilot: "Yes, but how much does it cost?"

shaft speed. The efficiency is assumed the same at cruising as at top speed, but is of course appropriately reduced for climbing.

Because certain of the weight items depend on cruising power, the drag (including induced) and efficiency become part of the final weight equation, which can be expressed in similar form for all of the design types, the variation being in the numerical coefficients of the different terms. The weight in turn is fed back into the drag equation from which the cruising power is determined. With the equa-

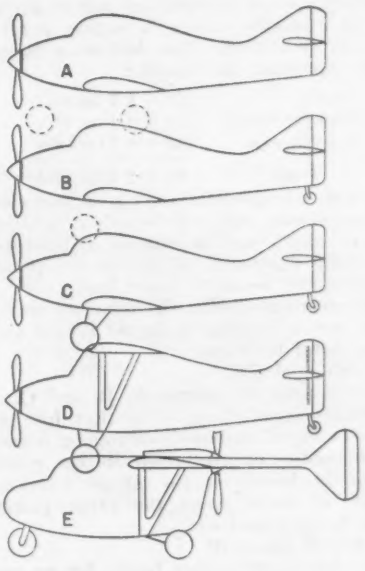
Table I — The Score Card
3-Place Airplanes

Design Type	A	B	C	D	E
Gross weight W (lb.)	2200	2115	2075	2185	2450
*Fuel and oil W_f (lb.)	213	208	232	282	339
Weight empty (lb.)	1412	1332	1268	1328	1536
Useful/gross (%)	35.8	37.0	38.9	39.2	37.3
Rated power (hp.)	129.5	124.5	122.0	137.5	165.5
Cruising $hp._{cr}$ (120 mph.)	79.0	77.0	86.0	104.5	125.5
Cruising/rated (%)	61	62	70	76	76
Drag area f (sq. ft.)	4.90	4.81	5.48	6.79	8.04
Wing area S (sq. ft.)	220.0	211.5	207.5	218.5	255.0
**Wing weight (lb.)	320	308	302	298	352
Wing span (ft.)	36.3	35.6	35.3	36.3	39.0
Max speed (mph.)	139.3	138.4	130.5	126.0	125.8
Max. climb (fpm.)	570	565	540	580	615

A—Cantilever, low-wing tractor; retractable tricycle gear.
B—Cantilever, low-wing tractor; retractable conventional gear.
C—Cantilever, low-wing tractor; fixed conventional landing gear.
D—Braced, high-wing tractor, fixed conventional landing gear.
E—Braced high-wing pusher; fixed tricycle landing gear.

All for aspect ration A = 6; cruising V_{cr} = 120 mph. at 7,000 ft.; rated hp. = W/17, or more if required for cruising; W/S = 10; W_f = 2.7 $hp._{cr}$. Useful load less fuel = 575 lb.

* Disposable portion (excl. tanks).
** Wing and bracing alone, without tail increment.



tions thus set up, we are ready to "turn the crank" and see what comes out.

Comparative Performance

What comes out in this particular comparison is shown in Table I, the Score Card. It will be noted that no one type can be said to have all the advantages. Even in this somewhat narrow field of weight and performance, each one of the five design types has at least some quality to recommend it. Type A has the best top speed; B has lowest fuel consumption; C has lowest empty weight; D has greatest useful load ratio; and E has best climb. The biplane has been similarly shown (by figures not given here) to have one definite advantage: compactness of dimensions.

But, considering the cost of attaining these various results, the finger of destiny seems to point in the general direction of Types B and C. As between these two designs, C is 64 lb. lighter in weight-empty, but burns about 0.8 gal. more fuel per hour. If, for example, we assume $3 per lb. selling price and 24¢ per gal. of fuel, the price difference of $192 would be made up in about 1,000 hr. This estimate of 1,000 hr. to make up the initial cost difference is probably low, especially in view of the higher relative cost per lb. of retracting gear, still without considering insurance and other fixed charges affected by the purchase price.

But even 1,000 hr. is a lot of flying for a private pilot; so, in spite of the extra top speed for Type B, it looks as if the award for best performance per dollar among these particular designs would have to go to Type C (low-wing tractor with fixed conventional landing gear).

Although this conclusion is at variance with that of previous articles,[1] it should be noted that there is no real inconsistency, since the comparison was then on a basis of speed without regard to takeoff. A similar basis for the present case, which with adequate takeoff facilities is perfectly proper, would give a clear-cut superiority to the retractable gear of Type B. Here, however, we have granted all benefit of any doubt to short takeoff. So the argument is still wide open and depends largely on how important short takeoff is to be.

On the evidence thus far, uncontested title to the booby prize goes to the pusher, Type E, as the heaviest, slowest, most costly, and biggest fuel imbiber of all five. It excels in the one item of climb only because it needs so much power to do anything else.

But still we have been talking only about performance and its cost. Many considerations of stability, control, vision, access, facility of landing and taxiing, etc., remain, together with possibilities of other variations of arrangement and use. These will be discussed in the next article, along with comparisons of specific features.

[1] "Save Money by Spending It." Upson. Sept. 1944 AVIATION; also Part I of this series, June 1945 AVIATION.

DESIGN DATA

a. Weights

For exploratory or creative design purposes, the gross weight is divided into:

1. *Basic or fixed weight*, consisting of "payload" (useful less fuel) with everything directly involved in housing such load, including most of the fuselage, furnishings, controls, and fixed equipment. For a given purpose, this item is constant, except for minor variations incident to the arrangement of the airplane as a whole. Included is a major part of the tail required to stabilize and control the fuselage volume and mass (except power plant). The component weights in this category are estimated as follows for the five comparative design arrangements:

Designs	A, B & C	D	E
Pilot and passengers (3)	510	510	510 lb.
Baggage and extras	65	65	65 lb.
Fuselage and booms	200	207	215 lb.
Tail surfaces	30	28	35 lb.
Controls and fixed equipment	150	150	155 lb.
Totals	955	960	980 lb.

2. *Fuel.* Including oil and tanks and comprising the items having to do with range, this is estimated as a function of the cruising engine power $hp._{cr}$:

Gasoline	$0 + 2.6\ hp_{cr}$ lb.
Oil	$9 + 0.1\ hp_{cr}$ lb.
Tanks	$6 + 0.3\ hp_{cr}$ lb.
Total	$15 + 3.0\ hp_{cr}$ lb

of which the consummable portion $w_f = 2.7\ hp_{cr}$.

As noted in the text, this condition is equivalent to the specified range at constant speed, altitude, and specific fuel consumption. Actually, the minimum fuel consumption for present lightplane engines occurs at a cruising power roughly 70 to 80 percent of rated. At lower relative power, there is a slightly decreased actual range (but probably increased engine life).

The fuel weight contributes practically nothing directly to the aerodynamic or inertia moment, and hence calls for no tail increment. The last of the three items is of course part of the weight of the empty ship.

3. *Power plant weight.* Here estimates are based on weights of existing engines and accessories plotted against *rated* power for the 50 to 200-hp. range. Re-

sults from a previous study[2] have been used with slight revisions, mainly to allow for an available saving in engine weight and for a starter. The following equations represent the results:

Engine	50 + 1.7 hp. (lb.)
Propeller (wood)	3 + 0.1 hp. (lb.)
Miscellaneous	32 + 0.7 hp. (lb.)
Total	85 + 2.5 hp. (lb.)

Where the miscellaneous item includes engine mount, exhaust, cowling, scoops, starter, and small increments of fuselage and tail, depending on the power plant weight (and hence on rated hp.).

In accordance with the assumed maximum power loading, W/hp = 17 and the above total becomes

85 + .147W

which applies to designs A, B, and C.

Trial computations show that for designs D and E the required cruising power is impossible of attainment if the rated power is based on the above relation. Hence in these cases the rated power must be increased to:

$$hp. = hp._{cr}/.76$$

where 0.76 is the power factor for an unsupercharged engine with fixed-pitch propeller at the assumed cruising altitude of 7,000 ft.

This last relation makes the alternative total of power plant weight:

85 + 3.29 $hp._{cr}$

which applies to designs D and E.

4. *Wing.* Here weight includes flaps and ailerons, struts, carry-through members, and an increment (approximately 10%) for the portion of the tail which varies with the wing). In accordance with the writer's published methods[3], the structural ratio or beam-weight parameter (for cantilever wings):

$$R = (\phi_s A^{3/2}/t)\,(\bar{y}_p/\bar{y}_s)^2 = 83.0 \qquad (1)$$

where the aspect ratio A = 6: root thickness ratio t = .15: lateral center of pressure in proportion to center of area $\bar{y}_p/\bar{y}_s$ = .92 (untwisted); taper factor ϕ_s = 1.0 (rectangle).

If W = W_s, the gross weight of the ship, the wing weight is then approximately (for wing loading W/S = 10 and limit load factor n = 4.5)

$$W_w = W[0.7(S/W)^{3/4} + 6.3 \times 10^{-6} \times RnW^{1/2}\,(S/W)^{1/4}] \qquad (2)$$

$$= W\,(.125 + .00075W^{1/4}) \qquad (2a)$$

Here the first term coefficient, for fabric covering or equivalent, is reduced to 70% of its value for average all-metal construction; but the second-term coefficient, although numerically reduced, is increased about 8% in effect, due to the neglect of the wing-weight moment. Although the supporting data are not as complete as for metal wings, it is believed that the second-term coefficient is liberal for continuous metal beam-flanges and associated members.

By use of a trial value of W = 2,200 lb., it will readily be seen that for this class of airplane the second or beam-flange term of the wing-weight equation is small enough to be approximated by a constant value within the parentheses in Equation 2a. Hence for present purposes, we may put for designs A, B, and C:

$$W_w = 1.60S = .160W \qquad (3)$$

of which about 22% represents beam material.

The remaining 78% or .125W can be assumed the same for the externally braced wings. The beam elements are then represented by spars, struts, fuselage follow-through members, and connecting fittings. An independent estimate of these, with credits for reduced shear and torque, gives .025W, or a total for design D:

$$W_w = 1.50\,S = .150\,W \qquad (4)$$

and, slightly modified for design E:

$$W_w = 1.52\,S = .152\,W/.96 = .158\,W \qquad (5)$$

5. *Landing Gear.* This includes retracting mechanism, if used, with wheel wells and any additional reinforcement required. It is estimated as follows for the five design types (for the approximate range and size involved):

Design	Landing Gear Wt. (lb.)
A:	20 + .097 W
B:	15 + .078 W
C:	10 + .055 W
D:	10 + .059 W
E:	13 + .073 W

The above figures are made fairly liberal to allow for long stroke and a reasonable amount of fairing.

6. *Weight Summary.* By collecting the constant terms, those in W, and those in cruising power from the last five items, we get the following expressions for the gross weight W:

A:	1075 + .404 W + 3 hp_{cr}
B:	1070 + .385 W + 3 hp_{cr}
C:	1065 + .362 W + 3 hp_{cr}
D:	1070 + .209 W + 6.29 hp_{cr}
E:	1093 + .231 W + 6.29 hp_{cr}

Evaluation of the total weight thus still involves one unknown—the cruising power—which of course depends on the drag.

b. Drag and Efficiency

1. *Basic drag,* analogous to the basic weight, is essentially that of the fuselage and the part of the tail surface required to stabilize and control it (plus booms in the case of the pusher). It is estimated as follows for the respective design types, in terms of the drag area f = SC_{Dpe}, where S is the wing area and C_{Dpe} is the coefficient of all drag which is constant with respect to lift:

Salesman: ". . . and complete to retractable ashtrays!"
Pete Pilot: "Why not retract the whole thing?"

A, B, and C: 2.00; D: 2.20; and E: 2.40. Terms are in sq. ft.

2. *Fuel drag* is assumed zero in all cases.

3. *Power plant drag* (cooling) area is assumed for all types:

.0063 $hp._{cr}$ (sq.ft)

equivalent to making the net efficiency .06 lower than the propulsive efficiency at cruising speed.

4. *Wing drag:* Including struts, interference, and tail increment, this is estimated to involve areas as follows for the respective design types (sq.ft.):

A, B, and C:	0 + .010 S = 0 + .0010 W
D:	.3 + .012 S = .3 + .0012 W
E:	.4 + .0125 S = .4 + .0013 W

The low-wing value is on a basis of C_{Dp} = .0067 wind tunnel value (NACA TR 669, airfoil 23015) for R N = 8.0 × 10^6; corrected to .0070 for R N = 5.7 × 10^6 — .004 fuselage interference (NACA TR 540 and 678) + .0025 for surface irregularities + .0008) tail increment.

5. *Landing Gear drag.* Including tail wheel and an allowance for residual drag of retracted wheels, this is similarly estimated as follows (sq.ft.) with exposed wheels partially faired (NACA TR 485, 517, and 522; TN 788):

A and B:	0.20 + 0
C:	.35 + .00025 W
D:	.35 + .0003 W
E:	.40 + .00035 W

6. *Propeller efficiency* η for fixed wood blades, at cruising speed of 120 mph:

A and B:	0.78
C:	0.77
D:	0.76
E:	0.74

c. Power and Performance

1. *Thrust power* at airspeed σ in mph. is given by the simple formula:

$$\eta\,hp._{\sigma} = \frac{\sigma\,\sigma^2 f}{146{,}600} + \frac{.39\,W}{\sigma\,e\,A}\left(\frac{W}{S}\right) \qquad (6)$$

in which the span[2] factor e has been given a mean effective value of 0.85. By substituting the assumed 6" .811 (at 7,000 ft.), A = 6 and v_{cr} = 120 mph., (6) becomes:

$$\eta_s hp._{\sigma} = 9.55 f_s + .0067\,W \qquad (7)$$

where, from items 3 and 6 (section 6), $\eta_s = \eta - 9.55 \times .0063$; and f_s is the summation of f values from items 1, 4, and 5 in section b. As for the term in W, its constant coefficient allows for the extra tail load in Type E, but not for the considerable induced interference commonly found in this type of plane.

2. *Cruising power* from Equation (7) reduces to:

A and B:	$hp._{\sigma}$ = 29.2 + .0226 W
C:	$hp._{\sigma}$ = 31.6 + .0262 W
D:	$hp._{\sigma}$ = 38.9 + .0300 W
E:	$hp._{\sigma}$ = 44.9 + .0330 W

3. *Gross weight* W is obtained by solving the equations in item a6, after substituting $hp._{cr}$ from c2 This known weight in turn is used in determining *other desired characteristics:* hp_{cr}, drag area f; consumable fuel and oil weight W_f and other weight components.

4. *Weight empty:* W_e = W − W_e − 575, from which useful load = W − W_e.

5. *Top Speed* (mph. at SL.):

$$v_m = 53\left(\frac{\eta hp.}{f}\right)^{1/6} - \frac{W}{3.6\,\eta hp.} \qquad (8)$$

for σ = 1.0; e = .86; and A = 6.0. Or alternatively use NACA TR 408.

6. *Climb* (fps. at SL.):

$$C_a = 17{,}300\,\eta hp./W - 620\left(\frac{f}{\eta hp.}\right)$$

for propeller C_{am} = 1.2 (empirically from NACA TR 408) for the same characteristics as item 5, η hp. being still the thrust power at top speed, not in actual climb.

The procedure represented in equations (8) and (9) assumes that cooling power increases directly with air speed and density.

These convenient formulas for lightplane design are from a number of such formulas which we aim to present, on a basis for broader use, later in this series.

[2] "Save Money by Spending It," Sept. 1944 AVIATION.

[3] "Performance Dictates Design," *Journal of the Aeronautical Sciences,* July 1940.

Time-saving resourcefulness, which make possible design and construction of P-80 in just 143 days, was typified by this quickly built engineering department building. Made almost entirely of engine box lumber, it was erected in just ten days.

HOW WE ENGINEERED THE LOCKHEED SHOOTING STAR

By C. L. JOHNSON, *Chief Research Engineer, Lockheed Aircraft Corp.*

The AAF gave Lockheed just 180 days to create and deliver the first P-80, radical new jet-propelled fighter. Here's the first-hand story of how it was done—in the unbelievable time of 143 days.

WHEN LOCKHEED AIRCRAFT CORP. undertook in 1943 to engineer and construct a radically new jet-propelled fighter airplane for the Army Air Forces in the hitherto unheard of time of 180 days—from start to finish—it was realized that an entirely new approach to the entire project would be necessary.

Because of the extremely tight time factor, Lockheed's conference system of engineering would not work out, and it was also apparent that the job could be completed successfully only if all responsibility and authority were concentrated in one man. Our engineering department had wanted for some time to engineer and build a plane from start to finish, and the XP-80 Shooting Star provided that opportunity.

Under Hall L. Hibbard, vice-president in charge of engineering, a separate group was set up in the company's engineering department for development of the P-80. Mr. Hibbard was able to visualize the advantages that would be gained if complete responsibility were concentrated in one spot; consequently, as chief research engineer, I was given a completely free hand to organize and direct this project.

Since speed was the essential factor, we began by securing a letter of intent from Wright Field. This was accomplished in one day by the simple expedient of walking the necessary papers from one office to another until they were completed. The company was then committed to deliver a jet-propelled fighter plane within 180 days from the time the last signature was received.

Our first problem comprised assembling of the necessary personnel and a decision on the best location for our project. My assistants were E. D. Palmer, head of our special projects department, who worked with W. P. Ralston, now P-80 project engineer, and A. M. Viereck, division manager of our engineering experimental department, who directed the shop group with L. F. Holt as assistant. Within 35 days we had a total of 23 engineers and 57 skilled mechanics assigned to the P-80 project. At our peak there were 128 men, 23 engineers, and 105 shop men in our group. Inspection was also responsible directly to me.

Because of the strict security regula-

tions imposed on the work, it was necessary to construct a new building away from other shop and office areas. A temporary building, of old engine boxes and canvas covering about 11,000 sq. ft., was erected by Lockheed plant engineers in ten days in an open area beside our wind tunnel. This enabled us to make use of equipment in the wind tunnel model shop, and it later proved very convenient for the frequent tunnel tests we ran on various parts.

At that time, machine tools were very difficult to secure, and we were forced to buy out a complete local machine shop in order to equip our layout. A minimum amount of work, actually about 4 percent of the total, was done in the regular Lockheed fabrication departments; everything else was held in one spot.

With our basic design laid out and the engineering and shop groups organized, a master schedule was developed. As soon as the major components were roughly designed, a joint meeting of shop and engineering personnel was held to decide on the type of tooling to be used. This was always the very simplest suited for the job.

On most other parts, Viereck worked out his own tooling directly from the part drawings. The engineers and shop men worked together directly throughout the project, and during the last three weeks practically all personnel were doing actual labor on the airplane. Inspectors worked directly from the drawing boards to the airplane, and with excellent results.

The bible of the P-80 project was our *Decision Book*, in which we made daily entries of the decisions made by the top group. Every decision was initialled, and any changes or deviations later agreed on were noted beside the original decision. In addition to providing a day-to-day guide to our work, the *Decision Book* now provides an accurate record of what was done at every stage of the airplane's development. Entries for a normal day might run as shown in the accompanying illustration.

Our first milestone was completion of a wooden mockup of the airplane 19 days after work started. We decided to make this mockup unusually detailed to avoid the possibility of changes. We guessed that if the mockup were unusually complete it might discourage changes. As it worked out when we held mockup inspection on the 19th day of work, no changes were suggested and a few eliminations were made.

Starting point for the P-80 project was the engine, which was to be supplied by the British. We had the drawings of this power plant, and after several months a wooden mockup of it was developed; but an actual engine did not arrive from England until the 132nd day of the project.

Nevertheless, we laid out the airplane—on the basis of specifications provided—around an engine none of us had ever seen. During our talks with Wright Field we had guaranteed certain performance figures and also provided a general outline of the plane we were to build. Our airfoil was based on an NACA equation for a highly developed laminar flow section. This type of wing would not work out well with a propeller; it was the first time the type had been given a fair chance to prove all its merits.

In spite of the fact that little test data was available on this airfoil, we went ahead and built the wing on the basis of our calculations, with the fond hope that wind tunnel tests would later bear out the figures. Fortunately this worked out, and our gamble in selecting an untested wing section gained us a tremendous advantage as far as schedule was concerned. We had of course, been working within compressibility ranges with the P-38 Lightning for several years and probably had an advantage in that respect over most other groups.

About the only change found to be necessary in the P-80 was a slight modification to improve the craft's stall characteristics and to make it less sensitive to minor changes in the wing's contours. For example, we discovered that the slight surface displacement caused by mechanics and pilots walking on the wing surface was sufficient to throw the plane completely out of trim. This problem was solved, and the P-80 today has excellent stall characteristics and a high degree of stability.

Good low aileron forces were achieved by application of hydraulic aileron boost, as developed in the P-38 and the Constellation four-engine transport. As in the P-38, the Shooting Star's aileron boost system has made the plane exceptionally maneuverable at all speeds and provides ease of control that will be highly satisfactory from the standpoint of combat pilots.

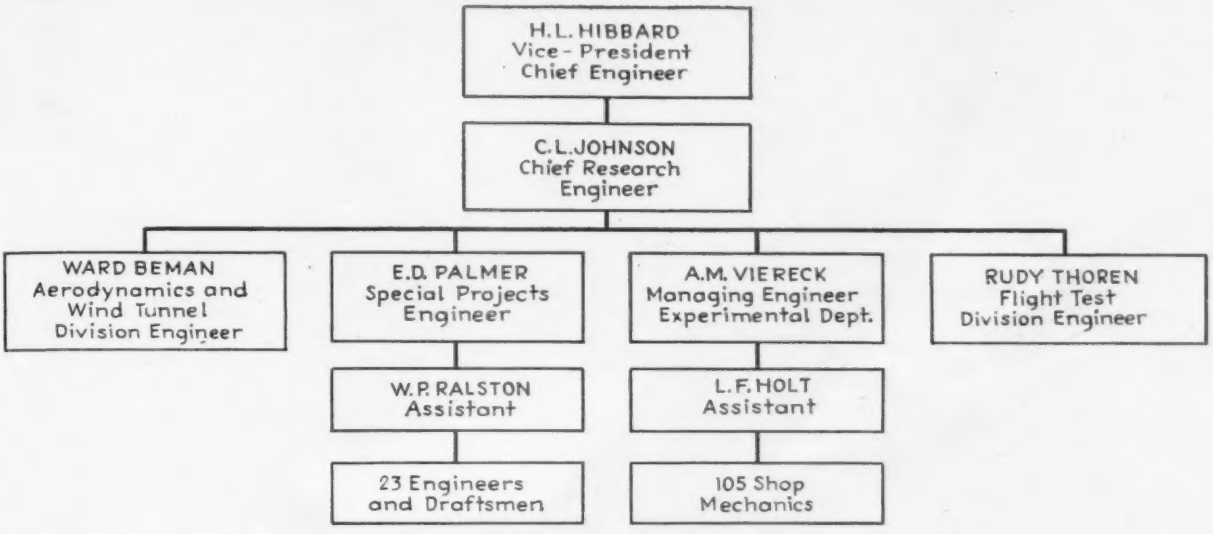
Our main problem in designing the fuselage of the P-80 lay in providing accessibility to the engine installation and installing the large amount of

DECISION NOTEBOOK

Subject XP-80 Date 7-2-43 (9) Page 1320 -6

1. L. G. shall extend and retract in 10 sec. (each way) at ½ engine rpm. (CLJ)
2. There shall be no anti-icing of any kind, except heating pitot tube. (CLJ)
3. Use vacuum gage selector valve, T & B vs other gyros. (CLJ)
4. Alternate static source valve shall be installed but not connected. (EDP)
5. Flap extension and retraction time 3 to 10 sec., depending on what the equipment will do. (CLJ)
6. Group electrical switches together and in logical order. (CLJ)--and provide cover for night flying switches. (CLJ)
7. Lower inst. panel 1" - arrangement is OK. (CLJ)
8. Duct lines may be derived from clay mockup as modified by CLJ. (EDP)
9. Duct flap to be flat with rounded L.E. and is to carry fillet. (CLJ) (Obsolete)
10. Interconnect wing tanks on each side with flapper valves to prevent leakage into outer tank from inner tank. This permits a 3-position tank selector valve. (CLJ) Obsolete 7-16-43.
11. The aileron hinge moment limiting relief valves are to be between the valve and cylinder. (CLJ)
12. Present battery is OK in spite of engine book calling for 40 A.H. Also our 320 sq.in. ducts (total) is OK as against engine book's call for 350 sq.in. (CLJ)
13. Aileron skin gage to be .025. (CLJ)

Typical daily entries in "Decision Notebook" which was "bible" during swift engineering of Lockheed P-80 Shooting Star. Book not only provided day by day guide for work, but now provides accurate record of development.



P-80 experimental group organization created within Lockhead engineering and experimental departments to expedite design and construction of Shooting Star.

armament. Once these problems were solved, we were able to go ahead with our development of a fuselage with optimum aerodynamic characteristics.

Wing and fuselage sections were designed, built and ready for mating on the 83rd day, right on schedule.

One thing that should be emphasized at this point is the fine cooperation we received at every stage of the P-80 work from Wright Field and especially from the officers assigned to our project. For example all Government-furnished equipment, such as guns, radio, wheels, tires, etc., were in our hands six days after we started work. Without that type of support we could never have succeeded in meeting the schedule.

Naturally the pressure on everyone concerned was intense. Everyone was time conscious, and to keep all hands apprised of progress we set up a big score-board calendar with the title Our Days Are Numbered. Every morning, the preceding day was crossed off—and some mornings that job was like pulling teeth.

At all times the relationship between engineering and the shop, and between supervision and the men, was extremely close. The engineers would finish a sketch, take it into the shop, and hand it to one of the men who would make the part. Or sometimes a mechanic would work up a part that was needed and hand it to us to make a drawing. That such a relationship could exist is indicative of the high type of men we were able to assemble.

Toward the end of the job, the pressure on our entire staff became even more intense, almost too much so. Early in the project we determined that we would schedule the work on the basis of a 10-hr. day and 6-day week. No one worked Sundays. However, as the last weeks rolled around we were experiencing a sickness rate that ran as high as 25 to 30 percent daily, due to poor facilities and absence of heating, and work would have been seriously handicapped had the project extended another few weeks. It was necessary to enforce the 6-day week for supervisory personnel since our small staff could not afford the loss of even one key man due to illness.

As various assemblies were completed, tests were run to check our calculations and assure the highest possible safety factor for the new plane's initial flight.

Before the P-80 left its hangar, we suspended the ship by belly bands and tested it for flutter and vibration. A complete load of fuel was pumped in and out, and the entire craft was shaken to test flutter modes. Complete brake tests were run before the plane moved an inch. We almost pulled down the shed during tests of the cockpit canopy release mechanism.

Once this phase of the work was completed, the airplane was disassembled and trucked to an Army test base where the first flight was made. On the 139th day of work the engine ran the first time the starter button was pressed, and one the 143rd day the airplane was accepted by the Army and pronounced ready for flight. We had beaten the contract schedule of 180 days—and our own private schedule of 150 days.

At all times, the entire project was kept as tightly restricted as possible, not only for Army security reasons but because we were fearful that the presence of other groups would result in delay. No other Lockheed departments were brought into the picture at any time—costs, scheduling, purchasing, all phases of the work were in our hands.

One evidence of the efficiency of this system as it was applied to the development of the P-80 is the unusually low cost of the prototype, only 63 percent of what it cost to build the prototype of the XP-38, a conventional twin-engine fighter constructed by the conventional system.

The Shooting Star was built with only 700 drawings, a factor which simplified the task of supervision considerably. Palmer and I personally inspected every drawing every day, and a close personal liaison was maintained between top men and all phases of the work.

The wartime advantage gained by the successful development of a revolutionary new fighter plane in less than six months is obvious. In one jump our Air Force moved ahead technologically of every other air force in the world.

However, we do not feel that a large airplane would respond to a similar development program. The problems involved are far too complicated and of too great a scope to be handled by a staff of 128 men. But we do feel that we have established the ability of a well organized research department to plan and carry out an advanced development program quickly and efficiently in an experimental department organized within an engineering department. As stated, we had wanted to do this sort of thing for a long time, and all feel well pleased with the results of the experiment, especially since it provided the United States with another advanced warplane.

Aeronautical Supremacy Demands Jet And Rocket Research

Republic P-47 ready to launch its ten 5-in. HVAR's (high velocity aircraft rocket), lethal and accurate missiles which first proved their worth in the St. Lo breakthrough and now being used with deadly effect against the Japs.

PART I

By ROY HEALY, *Vice-President, American Rocket Society*

ONE OF THE FEW beneficial aspects of this war has been the belated emergence of rocket research from the basement workshops of amateur experimenters into the great laboratories of governmental and commercial agencies.

Where in prewar days small groups of enthusiasts surreptitiously conducted experiments in isolated fields (frequently with illicitly obtained and transported materials, ever fearful of the descent of the local constabulary armed with prohibiting ordinance), today large bodies of research technicians are engaged in development and testing of the numerous rocket and jet propulsion devices evolved since the start of this conflict. This rapid mushrooming of rocket research, with the attendant publicity given the many spectacular applications of jet power lends considerable interest to speculations regarding the extent of postwar experiments in this field.

It is clear that many of the purely military devices utilizing rocket and jet power will not have direct commercial applications, although the basic propulsion methods may have numerous uses. At this writing all indications point to continued research, by all major powers, in the field of rocket weapons. The extent of government financed research in the United States will depend largely on the prevailing feeling of the people, either for disarmament or for a militarily strong nation.

This, in turn, will be affected by the success or failure of the major powers to reach amicable agreements at the peace conferences. Should it appear that all international disputes can be settled by a world organization, and the outlook be peaceful, research may be placed on a small and slow moving scale, reminiscent of the prewar years. But, should further conflicts be considered even a remote possibility, then military research will be continued on a vast scale with numerous organizations involved in the development and continuous improvement of rocket and jet weapons.

". . . The first essential of the airpower necessary for our national security is preëminence in research. The imagination and inventive genius of our people—in industry, in the universities, in the armed services, and throughout the nation — must have free play, incentive, and every encouragement. American air superiority in this war has resulted in large measure from the mobilization and constant application of our scientific resources.

"Comprehensive research, both within and without the air services, must be expressed in inclusive and continuing programs. Only in this way can our air forces reflect at all times the rapid advances in aerodynamics, physics, chemistry, electronics, the sciences basic to rockets, jet propulsion, radar, and revolutionary developments as yet unconceived." — General of the Army, H.H. Arnold Commanding General, Army Air Forces.

Forecasting startling future developments, this rocket expert declares that for peace or for war unceasing work in this new field is vital if America is to maintain her place in the skies.

Present research on jet propelled devices is conducted on a cooperative basis between various military services, civilian-operated government agencies, and commercial concerns. The foremost government body connected with development of rocket devices has been the National Defense Research Committee, a division of the Office of Scientific Research & Development. Various divisions of NDRC. have been undertaking solutions of the myriad problems involved in the design and application of rocket and jet equipment. The Research & Development Service of the Army Ordnance Dept., and the Navy Bureau of Ordnance, coordinating with the various using services, have developed and put into production rocket projectiles of impressive performance, the majority of which are still classified as confidential.

The technical trends to be expected, both for the remainder of this war and in any postwar program, can readily be summed up as, first, an increase in range, accuracy, and lethality of the many existing rocket weapons; and, second, introduction of directional controls in the larger longer-range missiles.

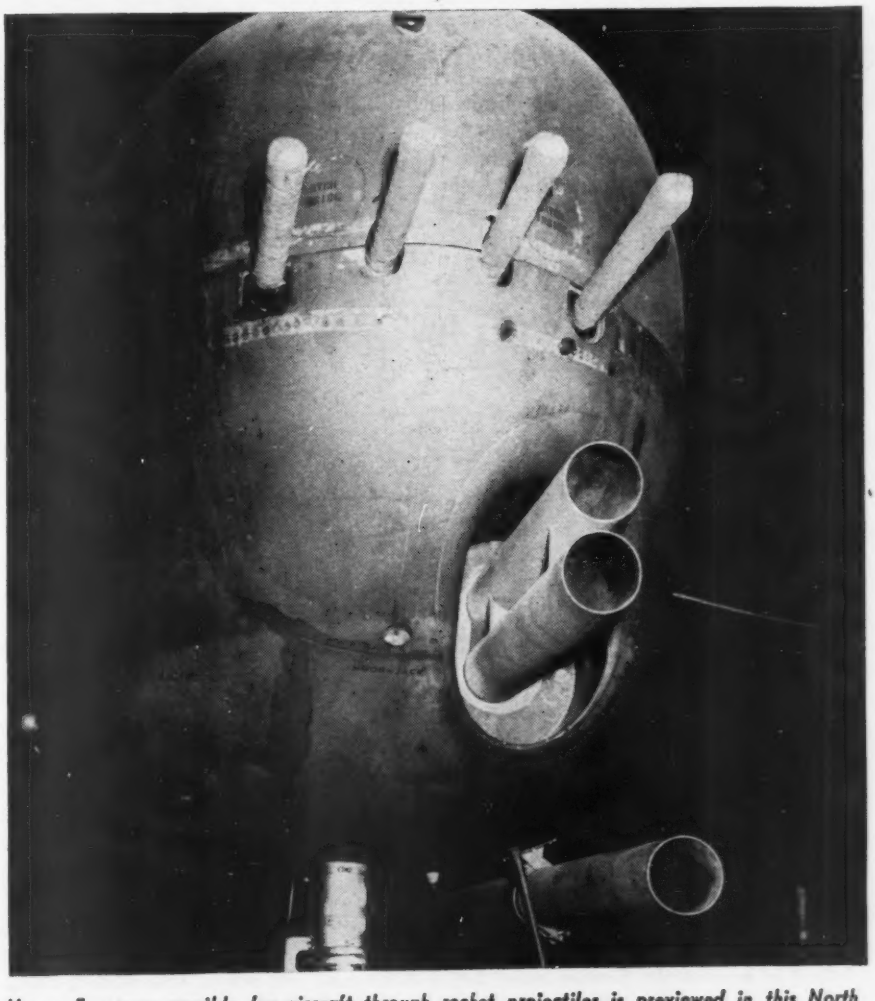
Although new and as yet unreported devices may evolve, the following weapons which have emerged during this war will undoubtedly be the focal points of most further development.

Aircraft Rockets

The natural combination of high speed aircraft and large caliber rocket shells, launched from simple, low drag, easily installed wing posts, was one of the major innovations of the war. Both the AAF, at its new experimental rocket field at Dover, Del., and the Naval Air Force, at its huge Inyokern, Calif., research and training base, are pushing engineering on larger, faster, and more powerful aircraft rockets, and also on more efficient methods of launching them from fighter, attack, and bombardment aircraft. Although the 21-cm. 240-lb. rocket (launched from the Me-109's and FW-190's at our bomber fleets, in the Luftwaffe's abortive attempts to halt demolition of Germany) is larger than anything the Allies have yet put into combat, experimental rocket projectiles are now being tested which will dwarf the German's best aircraft rocket, and use of giant rockets may be expected against Japanese targets.

The AAF introduced its first rocket projectile, the M-8, weighing 40 lb. and having a diameter of 4.5 in. in the CBI. theater early in 1944. Fired from clusters of paper-plastic tubes mounted under the wings of P-40's of the 14th AAF and P-51's and P-38's of the 10th AAF these rockets were found effective against Japanese targets in China and Burma.

Hardly had the M-8 gone in service when a new and more powerful rocket, the 5-in. HVAR (high velocity aircraft rocket), of several times the weight and potency of the initial round reached the combat service test stage. This round requires no launching tubes and is suspended from simple sheet metal posts fastened to the undersurface of the wing. Its lethal effect and accuracy was proven in its debut during the St. Lo breakthrough when,



Heavy firepower possible for aircraft through rocket projectiles is previewed in this North American B-25, armed with three rocket launchers in addition to 50-cal. machine guns. (AAF photo)

fired from P-47's of the 9th AAF, it struck telling blows against Nazi tanks, trains and truck columns. Most AAF fighters are now equipped to carry ten of these potent missiles which are now being used with deadly effect on Japanese armor, pillboxes, anti-aircraft batteries, shipping and rolling stock.

It is believed that the airborne rocket will gain importance as an aerial combat weapon, used both by interceptors and defensively by bombers, because of their longer range and large lethal radius when compared with aircraft cannon shells. Nazi aircraft, in the Luftwaffe's dying attempts, were reported equipped with rapid-fire reloadable launchers. Development of internally mounted rocket launchers is an endeavor that offers considerable promise, particularly in connection with jet aircraft at whose high speeds externally mounted rockets would create prohibitive drag.

Anti-Aircraft Rockets

Anti-aircraft rockets have been in use since 1939, first by the British while they were short of the more accurate cannon, then by the Russians in the defense of Moscow, later by the Germans as their anti-aircraft batteries were depleted and, of late, by the Japanese against our bombers. The possibility of control, or even limited correction, of the long-burning rocket carrying a large explosive head, makes the anti-aircraft rocket a likely subject for postwar research. Present anti-aircraft rockets do not possess sufficient range to menace high altitude bombers, but they have proved effective against low altitude attacks. Various forms of these have been used, some carrying high explosive heads, others showering phosphor pellets on the aircraft; also, many versions of the wire-tailed snare rocket have been put in combat.

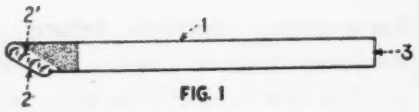


FIG. 1

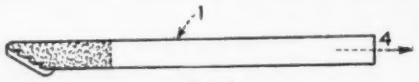


FIG. 2

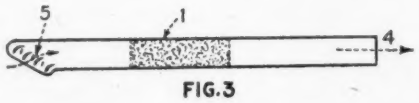


FIG. 3

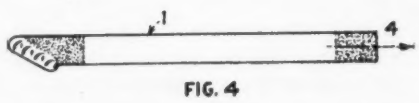


FIG. 4

Germany had a big lead over U. S. in developing jet and rocket power plants, as is shown by this basic patent drawing on impulse jet engine later used to power V-1 buzz-bomb. Patent was filed by P. Schmidt of Munich in 1931.

Rocket-Accelerated Bombs

During the Mediterranean campaign, the Germans experimented with rocket-accelerated bombs, for greater penetration of warship deck armor, and also with bombs having radio control devices on their tail surfaces for making limited corrections during descent. With further improvements in devices used by surface ships to elude bombers (such as the reverse bomb sight which aids in dodging falling bombs), the jet-accelerated bomb, with its higher velocity and using a radio controlled tail assembly for corrected descent, will tremendously increase the potency of the high altitude bomber.

The trend toward underground factories, which in another war might turn mankind into a troglodyte race, accentuates the advantage of the penetrating ability of the rocket bomb.

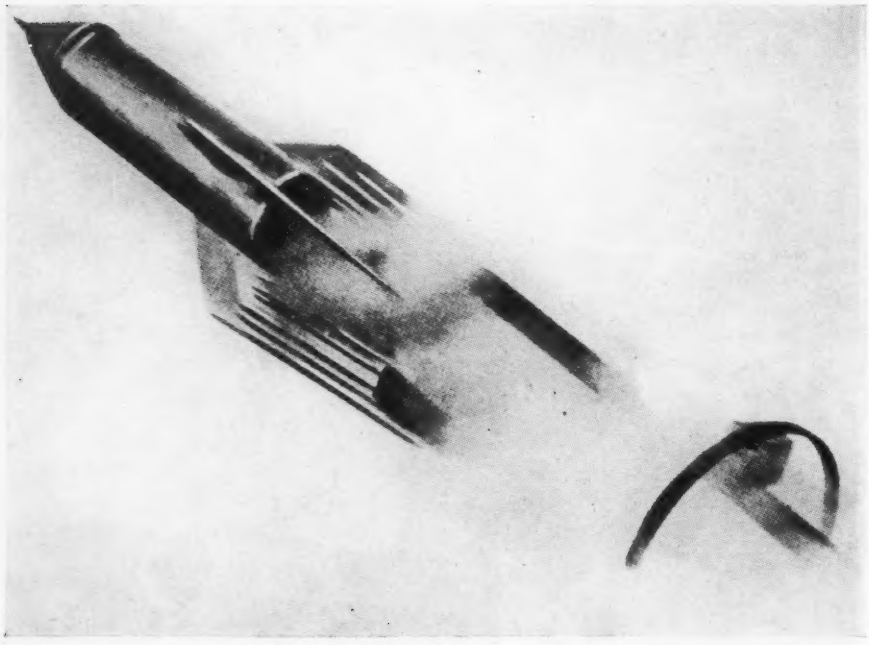
Rocket Torpedoes

Being simpler, cheaper, and possessing higher velocities than the conventional marine type torpedo, rocket-propelled torpedoes, both for shipboard and aircraft launching, will probably be seen in active service. Utilizing a solid-fuel driving charge to replace the complex alcohol-steam turbines now employed as motive power, the rocket torpedo will be as cheap and as easily produced as a bomb. More advanced designs of aerial torpedoes may use a stub-wing for greater range and may incorporate controls similar to those of the Henshel 293 rocket-glider bomb to allow attacks to be made from outside the ever-increasing range of shipboard anti-aircraft batteries. Research will not be neglected on aircraft-launched controlled rocket-glider bombs for use against land, as well as marine, targets.

Ground Force Rockets

Multiple rapid-fire launchers for infantry, naval, and amphibious attacks have been assuming a role of increasing importance as the war rolls toward Tokyo. Lightweight launchers on landing craft, tanks, amphibious trucks, and even jeeps, used in our island landings, have proven capable of saturating enemy held areas with devastating firepower.

Indicative of the importance attached to rocket firepower is the Navy's recently revealed expectation of expending $100,000,000 worth of this type ammunition monthly during 1945. The Army has an estimated $12,000,000 monthly allocated in this field, and these estimates may be increased if the already over taxed production facilities can be expanded. Aside from vehicle-mounted launchers, the infantry's "jungle launcher" has given the lone soldier an artillery weapon equivalent, in size of the rocket it projects, to a 105-mm. howitzer.



Takeoff of experimental German rocket before Nazis came into power. After Hitler's rise in 1933, secrecy shrouded further developments, results of which were not shown to world until V-1 and V-2 attacks on England.

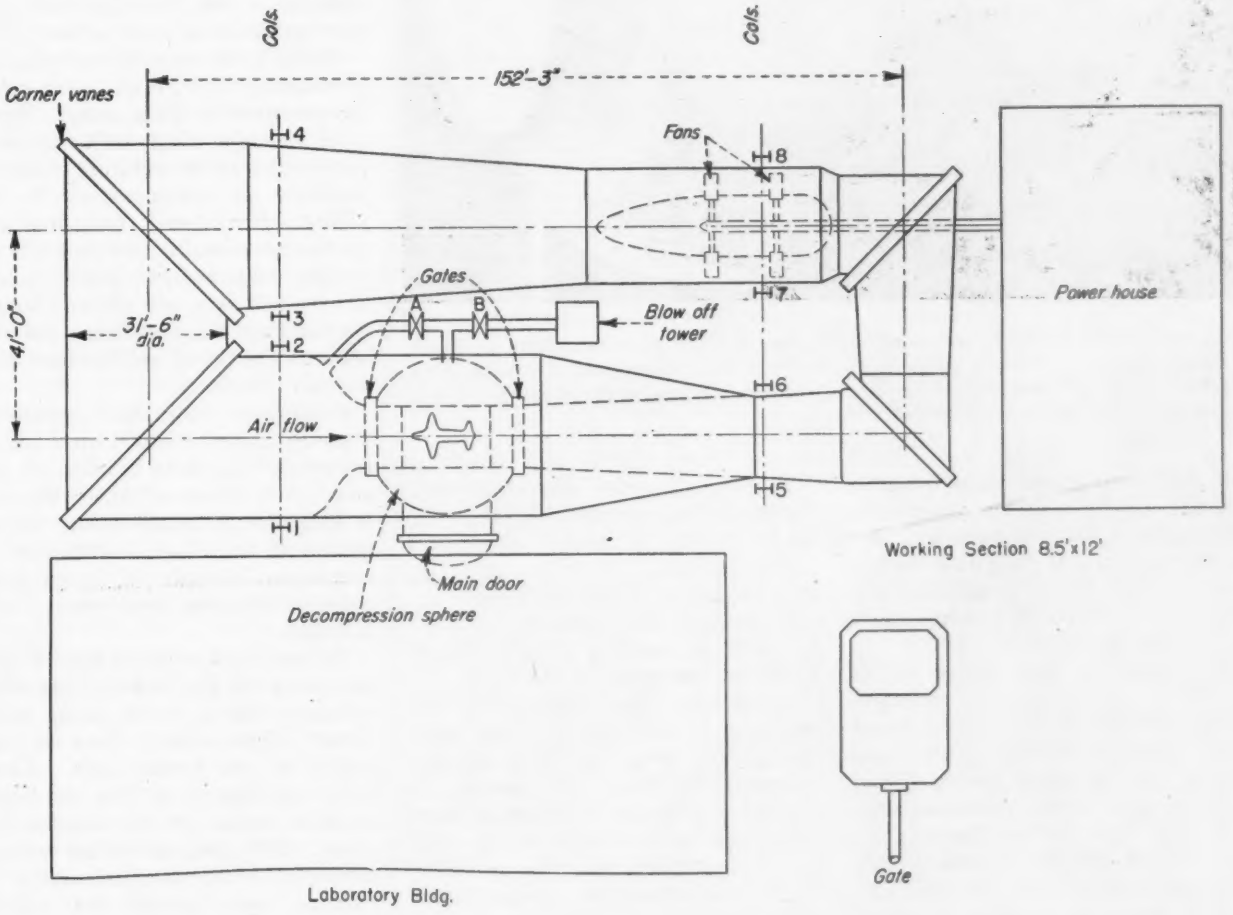
NEW WIND TUNNEL REACHES SONIC-SPEED RANGE

• The following members of the California Institute of Technology and the Southern California Cooperative Wind Tunnel staffs were primarily responsible for the design of major elements of the tunnel and prepared most of the basic material from which this article was written: Messrs. A. L. Klein, E. E. Sechler, M. Serrurier, L. G. Fenner, P. V. H. Serrell, A. Fejer, J. E. Smith, and F. M. Graf.

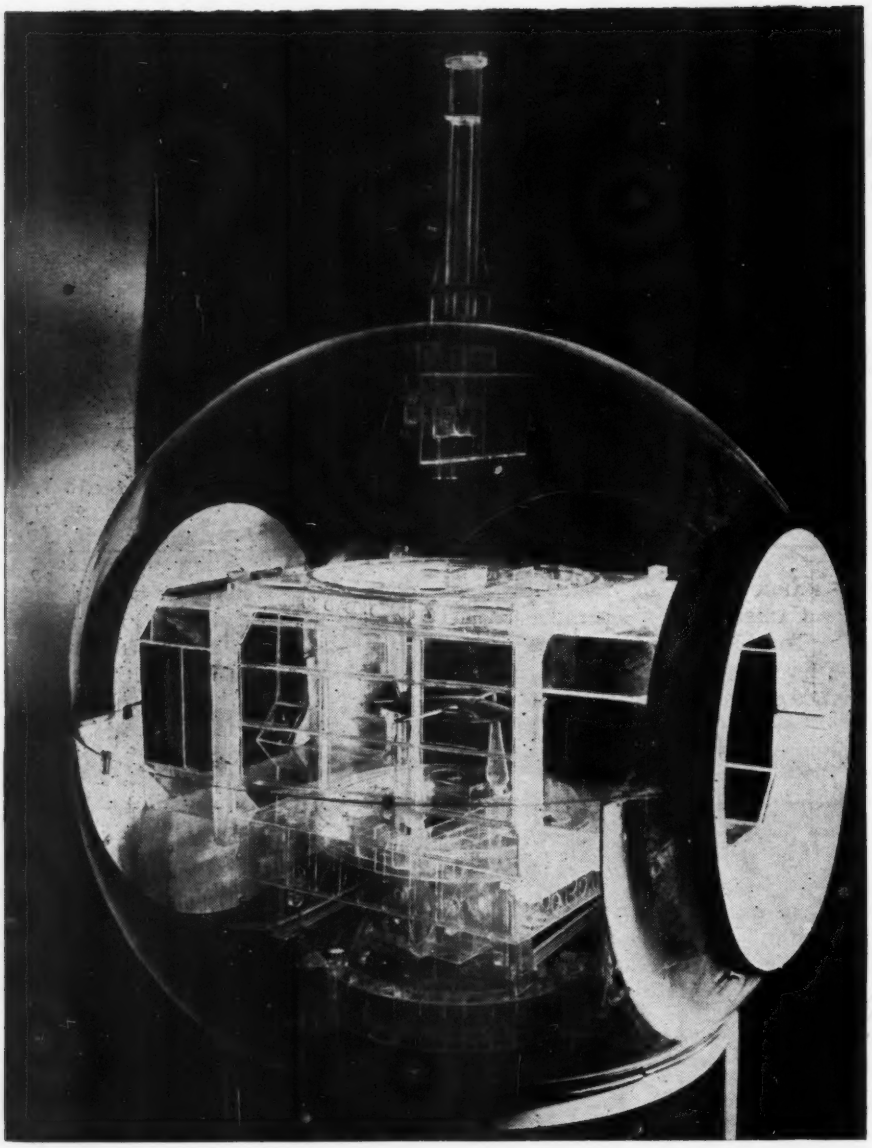
By CLARK B. MILLIKAN, *Acting Director, Guggenheim Aeronautical Laboratory*

Specially designed for fast test schedules, cooperative venture financed by West Coast airframe builders embraces new features enabling analytic checks at over 700 mph.

INAUGURATION OF THE SOUTHERN CALIFORNIA Cooperative Wind Tunnel in Pasadena places in service the first such research facility designed specifically for accelerated testing schedules. Among many new features of this large variable-density, high-velocity tunnel are several which are, up to now, unique. First, there is a decompression sphere enclosing the model and working section region; second, movable and interchangeable working sections on model tables; third, a multi-stage driving fan with



Layout of $2,500,000 Southern California Cooperative Wind Tunnel, financed by four West Coast airframe builders and operated by California Institute of Technology. Designed for accelerated test schedules, tunnel will operate at speeds in excess of 700 mph.



Plastic scale model of working section of tunnel, showing model plane in position on 50,000-lb. balancing system. Working section is enclosed in steel sphere so that if it is necessary to get at model under test this portion can be isolated from rest of tunnel and pressure or vacuum of 90% of system is undisturbed.

great flexibility of control; and, fourth, a model suspension system incorporating hydraulic-force measuring elements and electrical recording devices permitting test data to be automatically printed and entered on punched cards for machine computation.

This tunnel is also unique in its ownership and operation arrangements. Four aircraft companies shared in its cost, Consolidated Vultee and Douglas each assuming one-third, and Lockheed and North American one-sixth each. One half the design costs were carried by the Curtiss-Wright Corp., which is building an essentially identical tunnel in Buffalo. Direction and operation will be by California Institute of Technology staff of approximately 35 full-time specialists.

Let us consider the Cooperative Tunnel's new features in more detail:

The decompression sphere surrounding the working section is 31½ ft. in dia. Its model-table entrance is closed by a 12-ton steel door, 19 ft. in dia. Two gate valves cut across the airflow circuit up-stream and down-stream of the 8½ × 12 ft. working section. Rapid hydraulic operation of the gates and door permits the working section region to be hermetically sealed when testing is in progress. If it becomes necessary to contact the model, the working section can be sealed off from the balance of the tunnel and brought quickly to atmospheric pressure without loss of pressure or vacuum in the remaining 90% of the tunnel.

Second unique feature is the use of huge steel tables or model carts which carry the models into and out of the sphere on steel rails. Each has a different type of model support: wing tip, tripod, or NACA double strut arms. Two of the carts can be loaded or unloaded while the third is in place for a test, virtually multiplying the testing capacity by the number of carts, since no installation time and but a few minutes of hookup time ties up the working section between actual tests.

The third unique feature is made necessary by the fact that the tunnel reaches speeds in the 700 mph. range and very large Reynolds numbers by operating either at very low or high air density. Three compressors, located in the power house, can pump the tunnel to 45 psi. gage pressure in about 3½ hr., or evacuate it to ¼ atmosphere, or even to 1/10 atmosphere if required.

The problem of absorbing the full hp. over a range of densities of 16 to 1, corresponding to operation between these pressure limits of 4 to ¼ atmospheres, required that an unusual fan system be designed. Two propeller type fans, mounted in tandem on a single shaft, are driven by two electric motors having a total of 12,000 hp. This combination gives essentially the speed control and regulation characteristics of a full Ward-Leonard power plant system at a much reduced cost.

About 1,500 tons of steel plate, approximately 1 in. thick, were used in the construction of the tunnel. Since it is an air tight, single unit without expansion joints, temperature change expansions are accommodated by providing spherical ends (which offer no horizontal restraint) on the eight supporting columns. Horizontal restraint is provided by a pin midway between the third and fourth columns and a link between the tunnel and the base of the seventh column.

Cooling for continuous operation at a power input of 12,000 hp. limits air temperature to about 125 deg. A radiator, which removes 500,000 Btu/min., is located in a tunnel corner just upstream of the throat contraction. It consists of 80 units of finned copper coils, each having three rows of tubes in depth.

To insure the smallest possible pressure drop in the radiator the finned coils are placed in the plane of the corner ellipse rather than at right angles to the tunnel axis. Corner vanes turn the air 45 deg. and send it at right angles to the radiator face. About 3,600 gpm. of cooling water is circulated, being cooled in a tower and entering and leaving the radiator through the tunnel corner vanes which support the radiator.

A dehydrator controls humidity to eliminate inconvenience and complications which accumulation of moisture would impose. An air-to-brine heat-

Size of 16-blade, tandem-mounted fans and set of twelve prerotation vanes is clearly illustrated by workman, shown inspecting pre-rotation vane. Drive shaft is enclosed in housing extending (left center) from nacelle to power house outside tunnel.

exchanging coil, with the brine cooled by ammonia piped into the tunnel from a nearby commercial refrigerating plant, reduces the temperature of the air passing over it to about 40 deg. F. Tunnel air can be circulated through the dehydrator by means of a 3,000 cfm. circulating fan; and fresh air, entering the tunnel through the compressors, passes over the dehydrator enroute.

Requirements of the fan system are unusually severe. Operating at highest efficiency over the entire range of tunnel pressures, it must absorb the entire power input of 12,000 hp. Moreover, the pressure rise across the fan must be reasonably uniform over the cross section of the tunnel, and the flow leaving the fan must be closely axial in direction.

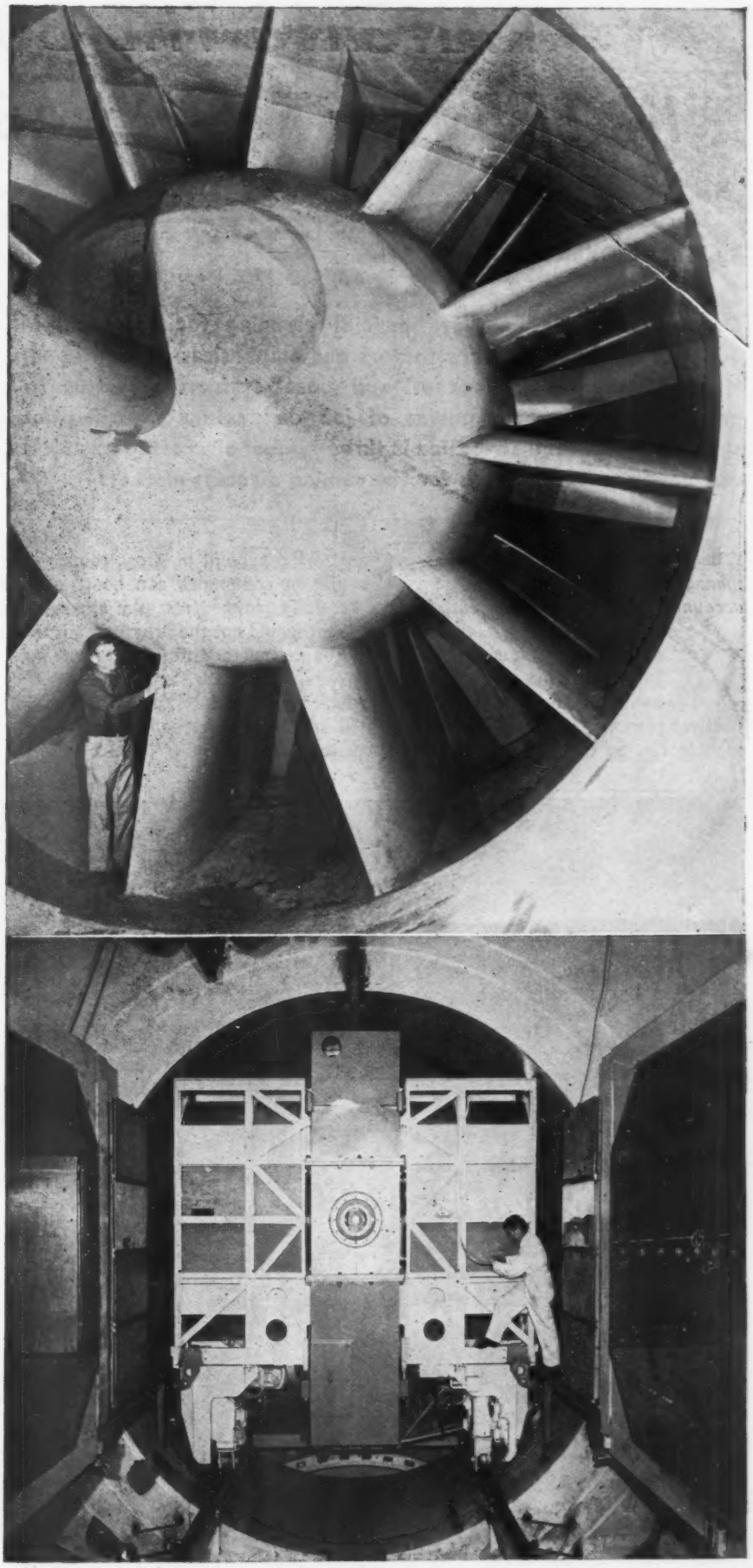
These requirements are achieved by two identical stages, each composed of a 16-blade, 21 ft. 9½ in. propeller-type fan, and a non-rotating adjustable set of 12 pre-rotation vanes mounted upstream of each fan. The fans are coaxially mounted with a clutch between the fan hubs, making it possible to use either both stages or the upstream stage only. Fan blades are of forged aluminum alloy, held in socket assemblies bolted to flats on the periphery of a 7-ft. dia. hub.

The blade sockets are forged alloy steel cylinders flanged at the hub attaching ends. Blades are rotatable on three angular contact ball bearings, the outer pair being stressed to carry centrifugal force loads of about 100 tons. Two bevel gear units and a planetary gear unit alter blade pitch, the latter requiring 2,600 turns for one turn of the blade.

The 16 flats on the outer periphery of the hub weldments are machined to give the blade axis an upstream angular inclination of 1 deg. 18 min. from the plane of rotation. This arrangement causes the centrifugal force moment on the blade to counteract a portion of the air thrust moment.

When the downstream fan blades are feathered, the disengaged clutch permits it to windmill to prevent Brinnelling of the roller bearing races. A 16 in. dia. hollow steel shaft, 30 ft. long, connects the upstream fan and the motors. Motors and drive shaft are connected by an extended type flexible coupling which permits an offset of

(*Turn to page* 254)



Models to be tested are mounted outside tunnel on one of three carts, such as that shown here moving into working section under its own power. Connections can be quickly made so that tests can be run while other two carts are being set up, feature which greatly increases test capacity of tunnel.

RANGING THE BUDGET IN THE POSTWAR LABORATORY

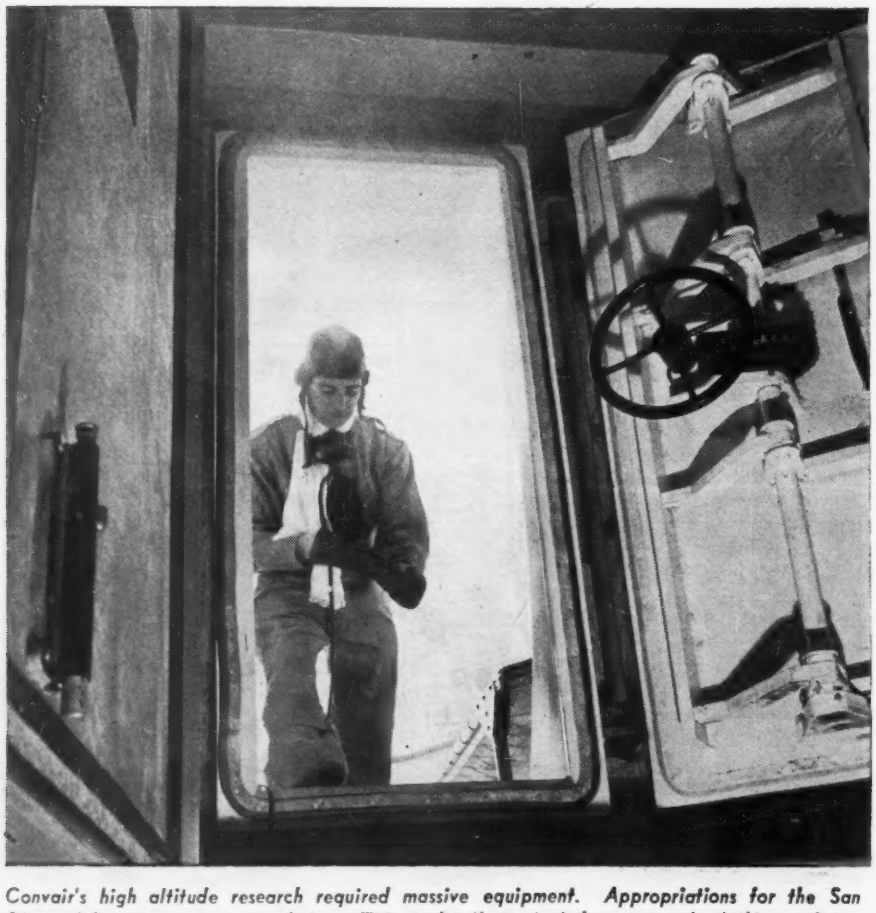
PART VII OF A SERIES

By K. R. JACKMAN, *Chief Test Engineer,*
Consolidated Vultee Aircraft Corp., San Diego

Continuing his critique of financial planning for research, Mr. Jackman details budgetary factors and emphasizes their vital role. He then compares the "docket" and "case" systems of cost control, presents specific breakdowns of job and salary classifications, samples personnel distribution in three typical aircraft laboratories, and gages research needs for the coming aircraft market.

"Budgeting is the arsenal of financial management, and its sentinel is cost accounting."—Management Maxim.

WE HAVE PRESENTED (Part VI June AVIATION) a few of the available figures to justify postwar planning in industrial research laboratories to the extent of approximately 2 percent of gross sales. Few aviation companies can boast of this carefully planned research expenditure —but would not the progress, advanced designs, and additional markets made available by such far-sighted research policy justify the expenditure? Trials in other industries have paid handsomely.



Convair's high altitude research required massive equipment. Appropriations for the San Diego laboratory were gaged in sufficient detail to include personnel clothing, gloves, accessories, and the like, as well as the financial specifications for refrigeration equipment and the 80,000-ft., 100 deg. F. chamber.

With the appropriation, to development and testing, of the necessary funds, buildings, equipment, and personnel, the obligations of the company are not filled. The board of directors of a progressive aviation corporation cannot, as it advances $1,000,000 to the laboratory director for the new year, reasonably say: "There you are, now set-to—research!" Careful financial and budgetary planning is necessary to economically use appropriated funds.

Since very little has been written on laboratory budgeting, the writer has attempted to collect, in these current Part VI and Part VII articles, a few pertinent facts as applied to aviation research, in order to promote public discussion of postwar laboratory problems.

Aero Laboratory Cost Control

Research control that has due regard for the intangibles in aircraft production development, and also regard for the time factor, is capable of making estimates of the value of laboratory results and of operating productively according to a budget.

It is believed by some specialists that a *docket system* of research control enables the laboratory director to evaluate with most certainty the cost of the work entrusted to him and his staff, and to ascertain a capacity load for the latter. This procedure also gives him the means to fix responsibility if changes are made in any of the projects under the docket. Such a system has been very successfully used in the Mellon Institute.[1-2]

A skeleton form for projects under a research docket and also a form for a time sheet for use in determining monthly costs of researches are given in Donald's very useful *Handbook of Business Administration.* In employing the monthly time sheet, as described therein by R. G. Caswell, each research laboratory employee records his own distribution of his time to the projects on which he has been assigned to work. By its use there can be calculated the distribution of salary to the projects.

Other items of expense, except supplies and special equipment which are charged to some specific tests, are generally prorated to the respective pro-

"LADDER" OF AVIATION JOB PROGRESSION

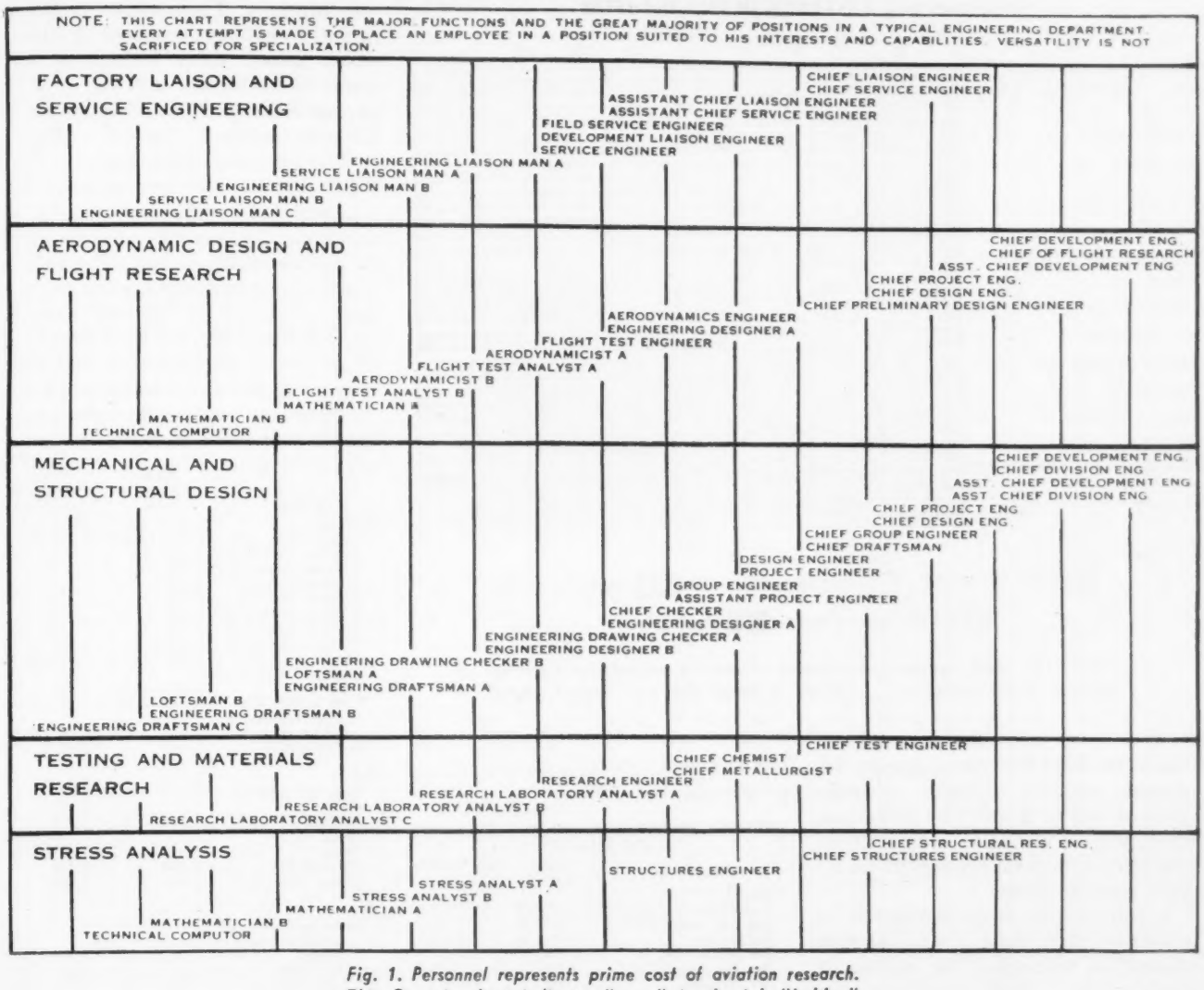


Fig. 1. Personnel represents prime cost of aviation research. This Convair chart indicates "rungs" in the job "ladder."

jects in the same ratio that salary charged monthly to a particular project bears to the total laboratory salaries. Among these items are cleaning, light, heat, power, steam, water, insurance, and depreciation. The depreciation rate of laboratory equipment is generally given as 10%.[1-2]

The *case system* of research control, used with success by Arthur D. Little, Inc., has been outlined by E. P. Stevenson. In this procedure, daily reports on special cards are said to afford a satisfactory means of recording the distribution of hours of working time of the laboratory staff. The accounting department then converts this time into dollars and cents, and these figures are followed in budgeting the time of the staff for the next month. A system of this type evidently has additional utility; for it enables the easy keeping of an accumulative record illustrative of the progress of tests in hand, and it makes possible the comparison of research project costs.[1-2]

The system used in cost analysis of development and research projects in the Engineering Test Laboratories of the Consolidated Vultee Aircraft Corp. at San Diego, is a combination of the "docket" and "case" systems, simplified to apply to aviation needs. Sections of the accounting department do this cost accounting for the Laboratories in man- hour collection of both engineering and shop time against test numbers. The test number, assigned to each test or development request as it enters the Laboratories, becomes the controlling medium (through simplified paper work to be discussed in a later part of this series) until the project is completed by the test report circulation to the requesting agency.

With the closure of each project the actual time expended by engineering and shop personnel is collected and compared with the estimated time allocation. Only by frequent checks of estimated against actual time expenditures can the test project engineers correct "poor guesses" and be educated for more accurate future "guestimates".

The expenditures for research or development in a large laboratory comprise the salaries and expenses of executives; office, library, shop, storeroom, and building operation and maintenance; salaries of research men and assistants; supplies and house charges, which will include as well special charges for shop and office work; and traveling expenses incurred during business trips and during the attendance of members of the laboratory staff at appropriate scientific meetings.

Salaries In Aviation Research

Prior to World War II, a man who chose to become a scientific investigator or test engineer by profession was expected to be prepared to sacrifice, in the interest of his scientific work, a certain amount of material prosperity as compared with that which he would probably be able to attain if he entered such other professions as the law and medicine.

With the increasing number of laboratories, the competition for capable workers and administrators is producing a considerable increase in the wage scales and it is not too much to expect

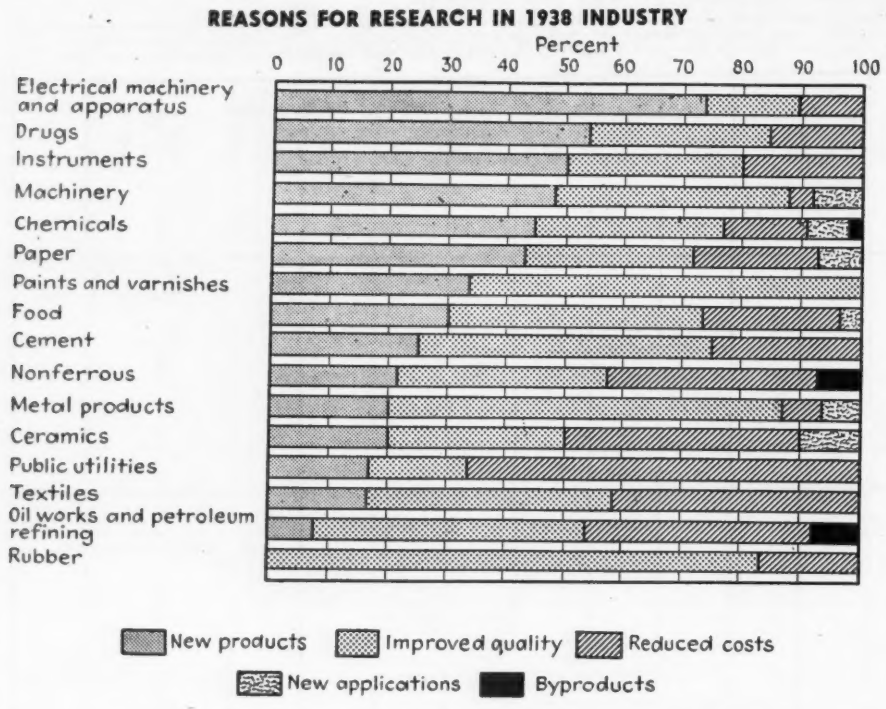


Fig. 2. This chart represents distribution of specific projects for industrial research in 16 industries. (WPA, National Research Project photo)

that in the next few years, despite the probable aviation cutbacks, scientific research will be a well paid profession which will be attractive even to those who esteem financial rewards above all other considerations.

A point which frequently arises in connection with the pay scale of men engaged in research is the method of remuneration. Should research men and test engineers receive a straight salary, or should they be entitled to an interest in the profits arising from their work? The judgment of most men directing large laboratories is definitely against any system of payment by results. On the whole, the best plan, according to Dr. Kenneth Mees,[III-1] of the Eastman Kodak Research Lab., is to pay men a fixed salary, advancing their salaries in proportion to the quality of their work, whether or not that work results in direct financial gain.

Initial salaries of test and research men and women will depend upon the person's educational background, previous experience, practicality, his publications and patents, and the importance of the problems being assigned to him.

The laboratory job classifications, requirements, etc., in the aviation industry will be more fully discussed in a future article. However, a few comparisons may be made. Rates of pay for specific jobs may differ throughout the nation, depending upon availability of trained personnel, costs of living, status of local housing, etc. However, the more common job classifications and salary ranges in the aviation testing and research laboratories are approximately as follows:

AVIATION LABORATORIES JOB CLASSIFICATIONS AND SALARIES

Classification	Hourly Rate*	Total Monthly Salary**
Technical		
Tech. Computor "A"	$ .85–1.00	$191–225
Res. Lab. Analyst "C"	.90–1.05	203–237
Eng'ing Asst. "A"	1.00–1.15	225–259
Res. Lab. Analyst "B"	1.10–1.30	248–293
Res. Lab. Analyst "A"	Flat	295–405
Res. Engineer	Flat	410–560
Clerical		
File Clerk	.75– .80	169–180
Depart. Clerk "B"	.80– .90	180–203
Depart. Clerk "A"	.90–1.05	203–237
Eng'ing Tech. "A"	1.05–1.25	237–282
Typist "A"	.75– .80	169–180
Stenographer "A"	.85–1.00	191–225
Secretary "A	1.00–1.15	225–259
Library Attend. "A"	.90–1.05	203–237

* Hourly rate based on a 40-hr. week. Normal 48-hr. weeks paid for with 1.5 x time for final 8 hr.
** Total salary based on 38-hr. week, with 1.3 overtime factor included. Flat salary does not pay overtime rates.

The education, experience, and job requirements of each of the above types of work found in most aviation laboratories will be examined in detail in a future article on laboratory personnel training. Other than the technical and clerical laboratory positions listed above, there are a few supervisory jobs —such as test group engineer, chief chemist, chief metallurgist, and chief test engineer—to be considered in completing the laboratory budget. Since the salary ranges of these administrative positions vary between companies in the aviation industry and more radically in other research laboratories, no attempt will be made here to define their salary limits.

The positions available through the U. S. Civil Service Commission and affiliated with laboratory work may be of interest. These jobs, underpaid when judged by the present overinflated salary scales in industry, will again be in demand with the cessation of hostilities and the reduction in industrial staffs.

The relatively lower pay of certain Civil Service positions is more than compensated, in many cases, by the continuity and security of employment in periods of depression. The postwar years will undoubtedly see this cycle repeated. A few of the more common positions now open in Civil Service as War Service appointments, and which may offer postwar laboratory security to some now engaged in industry, are as follows:

Position	Basic Annual Salary (40 hr. wk.)	Present Annual Salary With Overtime (48 hr. wk.)
Technical		
Admin. & Exec. Off.	$4,600–$8,000	$5,228–$8,628
Engineer, Asst. (P-2)	2,600	.....
Engineer, Assoc. (P-3)	3,200	.....
Engineer (P-4)	3,800	.....
Engineer, Sr. (P-5)	4,600	.....
Engineer, Princ. (P-6)	5,600	.....
Engineer, Head (P-7)	6,500	.....
Engineer, Chief (P-8)	8,000	.....
Metallurg. (P-1 to P-6)	2,000– 5,600	2,433– 6,228
Eng'ing Aid (SP-3 to SP-8)	1,440– 2,600	1,752– 3,163
Tech.& Scien. Aid	1,440– 2,600	1,752– 3,163
Eng'ing D'ftsman (SP-3 to SP-8)	1,440– 2,600	1,752– 3,163
Jr. Prof'al Asst.	2,000	2,433
Clerica		
Princ. Cl'k (CAF-6)	.....	2,797
Clerk	.....	2,189
Jr. Clerk	.....	1,752
Stenog.	.....	1,752– 1,970
Typist	.....	1,560– 1,970
Librarian (P-1)	2,000	2,433
Library Asst. (SP-5)	1,800	2,190
Shop		
Exper. Lab. Mechanics		
Aircraft & Eng. Mech.	.....	2,433– 3,828
Gen'l Mech.	.....	2,190– 3,163
Instr. Maker	.....	2,433– 3,163
Metalsmith	.....	2,190– 3,828
Electrician	.....	2,798– 3,163
Machinist	.....	2,433– 3,163
Welder (Comb.)	.....	2,798– 3,163
Woodworker & Carp.	.....	2,433– 2,798

In contrast to the above rates of pay, the statements made in 1936 by Weidlein and Hamor in their helpful book *Glances at Industrial Research*[1-2] may be more indicative of possible postwar salaries. "With no training other than that of the university, the suggested minimum entrance salaries for the first year, according to highest degree held, are as follows: B. S. $1,500, M.S. $1,800, and Ph.D. $2,400.

"It has sometimes been well stipulated that, in the event of substantial progress being shown, these beginning salaries will be increased at the end of six months to $1,800, $2,100, and $3,000, respectively. By this arrangement a probationary period will be provided for, and the self-respect and professional attitude of the man worthily stimulated.

"When the candidate possesses additional professional training, the conditions of his employment become competitive. In general, however, the salary should be comparable with that of men of equal experience already in the

laboratory. Even in this case, a probationary period of service is highly desirable. Salary advancement is necessary for its psychological effect, but must be judiciously administered for the same reason. A wise policy will provide for reasonable increases based on merit, at predetermined intervals if possible, seconded by family considerations." [1-2]

Such research institutions as the Mellon Institute have found that, with few exceptions, the salaries of the research men amount to about 60% of the gross cost of each industrial research project.

Job Distribution In Aero Laboratories

Probably the most rapid method of preparing an annual budget in an aviation research laboratory is to provide a lump sum for the salaries of the personnel employed, plus a contingency item, to cover materials, equipment, etc., and then to reappropriate for major items as they arise. Thus, were one to know the number of each classification of employee in a given laboratory, the yearly expense of the laboratory could be quickly computed within an accuracy of± 15%. Breakdown of all projects on the books at the end of the fiscal year and reapportionment of time to each for the new year, with allowances for new projects arising during the year, might not be much more accurate than the above ± 15%.

Let us therefore look at several aviation research, development, and testing laboratories of primary aircraft manufacturers for clues of personnel distribution. Three cases will be presented —"A", "B", and "C"—as indicative of the vast difference that exists in three laboratories doing approximately the same type of work:

Laboratory "A"

(Approx. 60% Applied Research)

Research Engineers	8
Research Laboratory Analyst "A"	10
Research Laboratory Analyst "B"	32
Research Laboratory Analyst "C"	45
Clerical classifications	5
Total	100 personnel

Note: Shopmen and planners attached to the laboratory were rated as Research Laboratory Analyst "B" and "C".

Laboratory "B"

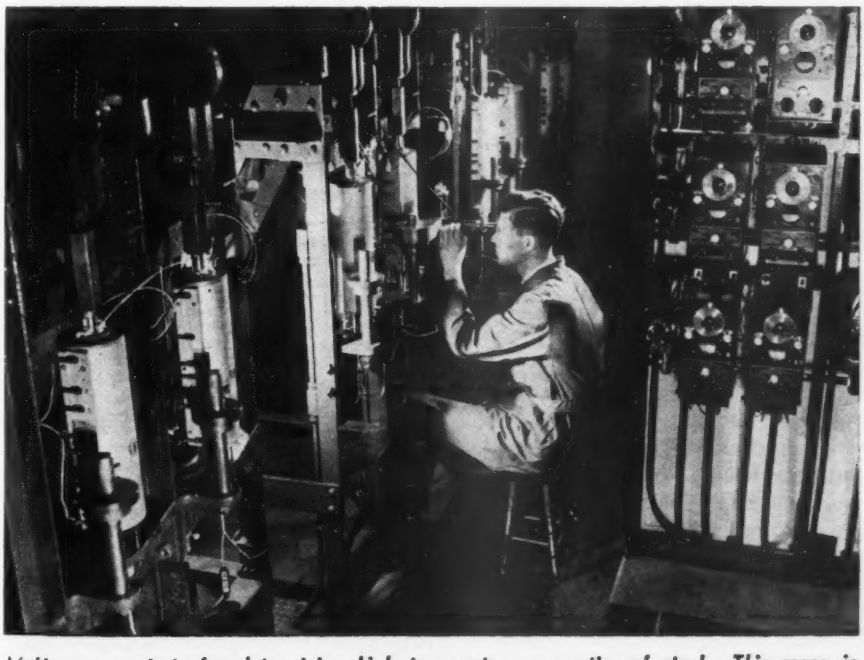
(Approx. 20% Applied Research)

Research Group Engineers	6
Research Engineers	25
Research Laboratory Analyst "A"	62
Research Laboratory Analyst "B"	30
Research Laboratory Analyst "C"	4
Engineering Draftsman "A"	9
Engineering Draftsman "B"	8
Planners	25
Shopmen (+ 5 key leadmen)	130
Clerical classifications	20

Laboratory "C"

Work Distribution	Number of Projects	Percen of Tota
Routine lab. control, shop proc., raw material	24	11%
Misc. new material invest.	77	36
Struct'l & strength tests	24	11
Operat'l & funct'l tests	53	24
Development tests	20	9
Research tests	18	9
Totals	216	100%

Personnel Distribution	
Chief Test Engineer	1
Chief Metallurgist	1
Chief Chemist	1
Group Engineers	2
Assistant Group Engineers	3
Research Engineer	1
Research Lab. Analyst "A"	26
Research Lab. Analyst "B"	23
Research Lab. Analyst "C"	11
Technical Computer "A"	1
Engineering Technician "A	2
Secretary "A"	1
Library Attendant "A"	
Department Clerk "A"	1
Total, Eng'rs & Clerical	75
Shopmen in Exper. Dept.	25
Total, Eng'rs, Cler., & Shopmen	100



Making creep tests for determining high temperature properties of steel. This scene in Battelle Institute indicates elaborate equipment sometimes necessary to carry on research. Many laboratories operate on budgets to make specialized test equipment. (Battelle photo)

It is interesting to note the difference in personnel distribution, individual work loading, and percentage of applied research tests to total projects of these three aviation laboratories. Still greater differences undoubtedly exist when comparisons are made between so-called "applied research" aviation laboratories and the "basic research" laboratories of the automotive industry and in several of the research foundations.

Some interesting facts are known about Laboratory "C" itemized above. Of the 75 engineers and clerical personnel, approximately 20 or 27 percent are women, mostly college trained with science majors. This particular laboratory was divided into eight distinct component parts, each specializing in specific fields as follows:

	Personnel	Percent of Personnel
Structural Tests & Res.	15	15%
Metallurg. Tests & Res.	9	9
Electric, Vibration, & Sound Tests & Res.	19	19
Chem. Tests & Res.	7	7
Physics, Spectrography, & Materials Tests	9	9
Mech. Tests & Res. (Hydraul., Pressure, Refrig., Tests, etc.)	7	
Cler. (7) & Top Supers. (2)	9	7 2
Shop Pers. (Exper. Dept.)	25	25
Tota Personnel	100	100%

If the engineering personnel in this laboratory, who contributed to the preparation of test and research reports, were to be separated from the shop, clerical, supervisory routine testing, and report coordination personnel, it would be noticed that approximately 47 engineers, metallurgists, and chemists carry approximately 200 of the 216 projects, or average over four projects per person at all times. This personnel work-loading varies with the experience and competence of the individual, from one in new Research Laboratory Analyst "C"'s to as many as eight projects in the case of several of the senior R.L.A. "A"'s.

It is obvious from the above comparisons of laboratory personnel, work loading, and classification that the "postwar" budget of aviation laboratories is an unknown factor, since the present importance of high-speed production will then give place to more development and reseach projects (it is hoped!), with the inevitable desire of "top management" to "economize" in all departments.

To many of those people most familiar with research laboratories and their importance in tomorrow's world, this attempted "economy" in research budgets may well cause considerable thought and discussion. Possibly the postwar position of research in each company should be decided *today* when calm reasoning is possible, and ***not tomorrow*** in the excitement of victory

parades, curtailment of contracts, and postwar competition.

A Wise Postwar Research Economy

Realization of the importance of continuing aeronautical research after the war is apparent in the aircraft industry. Most aircraft companies, if the government leaves them with sufficient funds after contract terminations, contemplate sizable investments in research development departments to make best use of findings unearthed by private and government agencies, such as the NACA, Wright Field, The Bureau of Standards, and the Naval Aircraft Factory.

But what will the individual aviation company be building one year, two years, or five years from today? What are the commercial aviation possibilities? How many planes will our government services need in early postwar years? What will be the commercial transport requirements, and how many planes will be called for by private owners?

Probably as good a guess as any was that recently published by Wm. A. M. Burden in the *Harvard Business Review.*[VI-9] The probable magnitude of the postwar aircraft orders is shown in the following table from that publication:

POSSIBLE ANNUAL SALES OF U. S. AIRCRAFT INDUSTRY IN NEAR-TERM POSTWAR YEARS

Type	Number Planes	Value Each ($000)	Totals ($000)
U. S. Mil.	5,000	$200	$1,000,000
U. S. Trans.			
Domestic 40 Pass.	200	400	100,000
20-30 Pass.	100	90	10,000
nternat., 40-50 Pass.	40	500	20,000
U. S. Private	50,000	2	100,000
Exports	.....	.....	40,000
Total			$1,270,000

If Burden [VI-9] is correct, it would appear that the majority of the aircraft manufacturers will be contractors to the Army and Navy. This probably being the case for early postwar years, it would appear desirable to consider the place of research and testing in the new contracts.

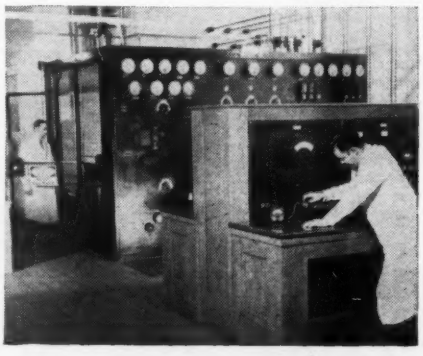
Much of the development and research work that has been done to bring out advanced types of planes in the last ten years has been carried out in addition to, or in spite of, the formal contract. Structural testing of aircraft components is—most assuredly—a part of every service contract; but much development and research has to be done that is not written into contracts. Why should research on these new planes not be emphasized and "incentive contracts" written to cover this important phase of aircraft production?

It is interesting to note that increased interest is being shown by the U. S. Navy Department in so-called "incentive contracts", incorporating specific expenditures for prototype testing and research, and it is considered probable that the Navy, and possibly the Army, will extend the use of such contracts in future dealings with aircraft manufacturers and with others producing for the Services in the early postwar years. Some executives of companies that have operated under this plan believe that it is better than cost-plus-fixed-fee plans, and also better than fixed-price contracts under wartime conditions, in that financial risks are more nearly eliminated.

Leeway for Research

Under the incentive-contract plan, the Navy and contractor agree on the basic cost of an item plus 10 percent profit. It is believed by the writer that the basic prototype-plane costs should include generous allowances for the development and research tests always necessary on new planes and that this research expense should not be deducted from the contractor's just profits.

For example: With the basic cost of a bomber prototype, including the necessary research on structures, etc.,



Switch panels in Chrysler laboratories. Comprehensive operating panels key the precise work in well-equipped and well-maintained research rooms. Hence, specific budgeting is indicated for this and other primary equipment. (Chrysler Laboratories photo)

set at $1,000,000, the cost-plus-ordinary-profit would be $1,100,000. The contractor is then given additional latitude for unforeseen expenses, which might rise the total, say to $1,300,000. With completion of the contract, the contractor would have to support any costs between $1,100,000 and $1,300,000, the top price he would receive for the plane. He could receive $1,300,000, but no more. And if the cost was $1,290,000 his profit would be only $10,000.

On the other hand, if production costs were reduced to, say, $980,000, the contractor would receive not only the original 10% profit agreed upon but in addition a percentage of the difference between $1,100,000 and $980,000, with consequent saving to the government.

It is encouraging to note that some thought is being given to aviation futures by such groups as the Woodram Postwar Military Policy Committee, by several Aircraft War Production Committees, by an NACA group, and by a few scattered companies and individuals. Maj. Gen. Oliver P. Echols, assistant chief of air staff, material and services, recently told the Woodram Postwar Committee that it is of the utmost importance that the aircraft manufacturers maintain relatively large and competent engineering staffs and that these engineers should be kept constantly at work on the development of new designs of aircraft and accessories.

The AAF officer did not elaborate on present or postwar plans for maintaining engineering staffs of the aircraft industry—which was hampered in prewar years because it was not permitted to assign engineering, development, and research test costs to service airplanes—other than to say that research and development did not depend so much on facilities as it did on the money made available to utilize these facilities.

While the text of these specific financial-problem articles can do no more than touch upon the many phases that exist of laboratory finance and budgets, it is sincerely hoped by the writer that sufficient controversial points have been suggested to inspire constructive criticism and good-natured arguments—we hope in the form of more such articles by others—all for the better understanding and closer cooperation among those entering the promising postwar period of aviation research.

(To be continued in later issues)

References to Part VII

For those researchers who wish to study further, the following references are offered. (Note: Articles once referenced in any part of this series will be referred to both by part number and by reference number, i.e., (II-6) indicates Part II, Reference 6.

(VII-1) *Applied Research* by Dr. Harry R. Ricordo, F.R.S., from Presidential Address to Institution of Mechanical Engineers, London, Oct. 20, 1944.

(VII-2) *Postwar Status of the Aircraft Industry* by Wm. A. M. Burden, *Harvard Business Review*, Winter, 1945.

(VII-3) *Industrial Research Expenditures* by Karl T. Compton, Section II-8 of *Research—A National Resource*, II *Industrial Research*, Dec. 1940.

(VII-4) *DuPont Research* by Dr. E. K. Bolton, an address before American Section of Society of Chemical Industry, New York City, Jan. 5, 1945.

(VII-5) *Research Makes Jobs*, by Dr. Cole Coolidge, E. I. duPont de Nemours Co., an address before *N. Y. Herald-Tribune* Forum.

(VII-6) *Pennsylvania Salt Manufacturing Co. and Research*, Pamphlet by Penn. Salt Mfg. Co. (Whitemarsh Research Labs., Philadelphia, Pa.), 1944.

AERO COMMANDER IS NEW LIGHT TRANSPORT

As soon as materials are released, Aero Design & Engineering Corp. will build twin-engine five-six place craft of all-metal design with tricycle landing gear. Price is ranged at $12,500 and up, according to equipment and furnishings.

CONSTRUCTION OF A NEW executive-charter-feederline plane is now projected by the recently formed Aero Design & Engineering Corp., Culver City, Calif., and production of the prototype is expected as soon as the "makings" are available.

Now in the mockup stage, the craft has been designated the Aero Commander L-3804 and is to be a cantilever high wing monoplane powered by two 190-hp. Lycoming six-cylinder engines. Designed to seat a pilot and four passengers, there is also to be enough space for a sixth seat if regulations permit. Seats could be removed for conversion to cargo service. The Aero Commander is expected to sell for $12,500 and up, depending on interior furnishings and equipment specified by buyers.

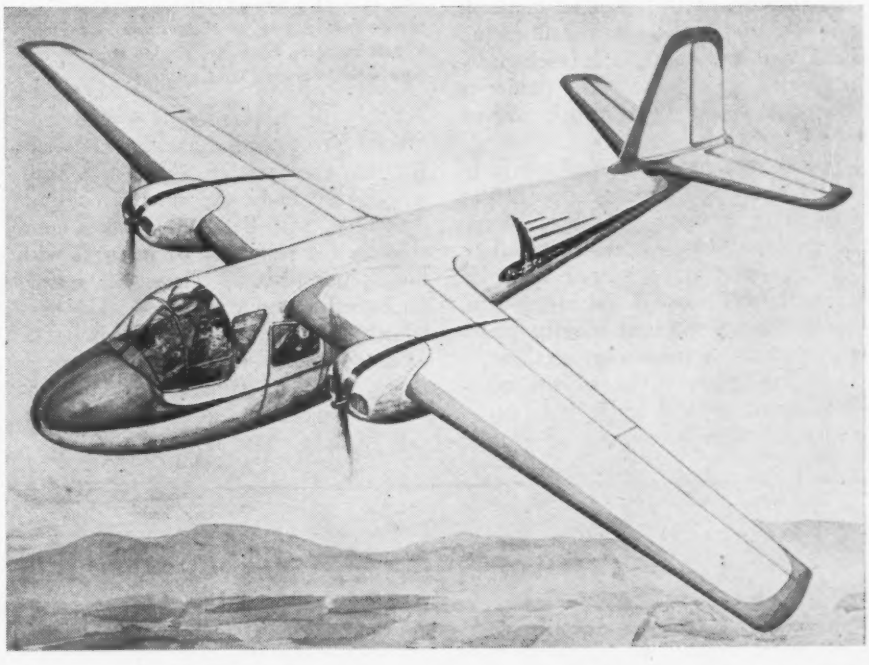
It is stated that the craft will have a top speed of 181 mph. at sea level, while on one engine maximum speed would be 135 mph. At 75% of rated power, operating speed is to be 165 mph. Stalling speed at sea level with flaps up would be 64 mph., and with flaps down, 57 mph. Speed for maximum L/D is estimated at 89 mph. and maximum L/D with flaps up at 12.2.

The Aero Commander's service ceiling would be 24,400 ft., and on one engine the craft's ceiling is put at 11,500 ft. Rate of climb at sea level, it is stated, will be 1,740 ft. the first minute. The endurance at operating speed is to be 3.8 hr., with 80 gal. fuel capacity, or a range of 700 mi.

Performance figures include a run of 1,350 ft. to clear a 50 ft. obstacle; and landing distance to a stop, after clearing a similar obstacle, is estimated at 850 ft.

Gross weight of the craft would be 4,200 lb., and it would weigh 2,500 lb. empty. Called for is a wingspan of 43 ft. 10 in., an over-all length of 32 ft., and maximum height of 10 ft. 4½ in.

An NACA 23012 airfoil will be utilized for the wings at both root and tip. Area will be 240 sq. ft. with flaps retracted, and including ailerons and tab which will have a combined area of 20.8 sq. ft. Root chord is given as 100 in. and tip chord as 33 in. Taper ratio is to be .33 and incidence at tip 2 deg. Dihedral is to be 4 deg., and aspect ratio of 8.16 will be used. M.A.C. will be 72.122 and M.A.C. location relative to leading edge of root chord is to be 110.26 horizontal and plus 6 in. vertical. Flap area will be 31.5 sq. ft. and flap mean chord 19.7 in. Maximum angular deflection is to be 45 deg., and aileron angular deflection will be 30 deg. up and 20 deg. down. A differential motion of 1.5:1 is planned.



Sketch of projected five-six place Aero Commander L-3804 light transport which is now in mockup stage. Company states that construction of a prototype will begin as soon as materials are released. Craft is to be powered by two 190-hp. Lycoming engines, and top speed is estimated at 181 mph. at sea level. A cruising range of 700 mi. is planned.

Wing is to be a full-cantilever semi-monocoque two-spar aluminum alloy structure, built in four main parts—left and right panels (extending from the fuselage center line to within 8 in. of the tips) and left and right wing tips. Ribs will be aluminum alloy with aluminum alloy extruded sections running spanwise with aluminum alloy sheet covering. All surfaces forward of the spar are to be flush riveted. Main panels are to be joined to the fuselage by aluminum alloy fittings and steel bolts. Wing tips are to be attached using completely recessed flat head machine screws and self-retaining-nut plates.

Ailerons will be built up on one spar with fabric covered aluminum ribs. Aerodynamic and static balances are

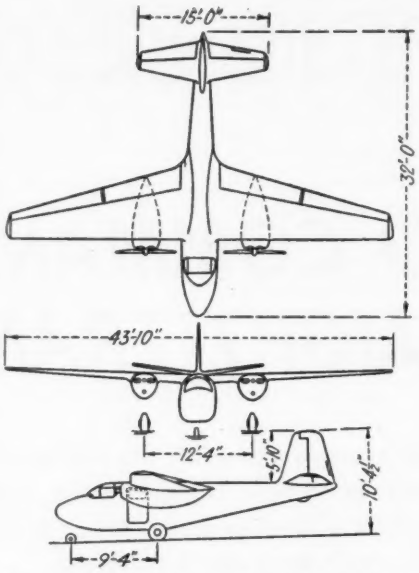
to be provided integral with the ailerons at the extreme tips. A trim tab in the left aileron is to be adjustable from the ground.

Horizontal tail surfaces, including fuselage, are to have a 15 ft. 4 in. span, 57 in. maximum chord, and will contain 51.25 sq. ft. of area. The horizontal stabilizer is to have a total area of 23.25 sq. ft., and the elevator 18 sq. ft. Elevator tab area will be 72 sq. in. Vertical stabilizer including fairing, will have an area of 16.06 sq. ft., and rudder including tabs will have 13.1 sq. ft. of area. Rudder tab area will be 48 sq. in.

Planned for the horizontal stabilizer is full-cantilever all-metal one-piece construction, with 10 deg. dihedral to elevate stabilizer tips above the wake of the wing and to provide added stability. Construction of the elevator will be similar to that of the ailerons. The vertical fin will also be made in one piece, full cantilever, and all-metal, and it will be fitted to the fuselage by means of tension bolts. The rudder is to have an all-metal framework covered with fabric.

The semi-monocoque fuselage is to have a maximum cross section height of 64 in., a maximum width of 54 in., and is to be of all-metal construction. Channel-type frames, spaced about 26 in. apart, will support the metal skin, which will be stiffened longitudinally by extruded aluminum alloy sections.

Landing gear, to be of the completely retractable tricycle type, is to have main wheels mounted on single, braced oleo pneumatic struts conforming to specification ANC-1. Main wheels are to be the smooth contour, disk type, with hydraulic brakes actuated by toe pedals to be integral with the rudder pedals. They will retract aft into the engine nacelles. The nose wheel, also smooth contour, is to be mounted on a single oleo pneumatic shock absorber strut. It will be capable of swiveling up to 30 deg. each side of center and is to be fitted with a spring snubber. Retraction will be forward and up into the nose.



Three-view layout shows all-cantilever design. Construction is to be all-metal, with exception of fabric-covered control surfaces. Tricycle landing gear is retractable, with main wheels swinging back into engine nacelles and nose wheel forward and up.

Fuel tanks, of the rubber bladder type, are to be located in the leading edges of the wings inboard of each engine. Individual fuel systems will incorporate gravity feed.

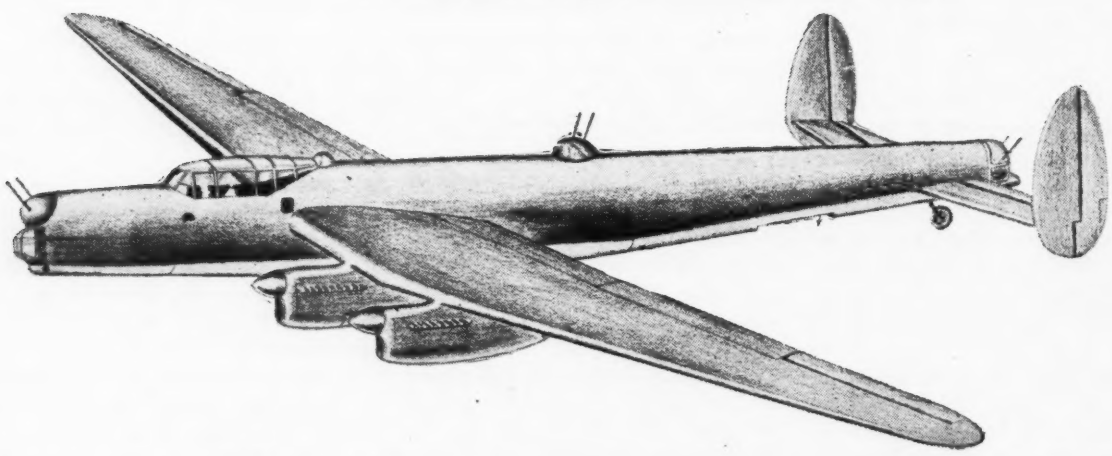
It is stated that commensurate with the weight involved, Sea Pack soundproofing will be used. The baggage compartment, just aft of the rear passenger seat, is to accommodate four average size suitcases and will be accessible in flight.

Founders of Aero Design & Engineering Corp.—incorporated in Dec. 1944 in California with an authorized capitalization of $1,000,000—are a group of aero engineers connected with several of the Southern California airplane companies. President of the new company is T. R. Smith, who was formerly project engineer on the Douglas A-20 attack-bomber series, and Paul A. Leaman is secretary and treasurer.

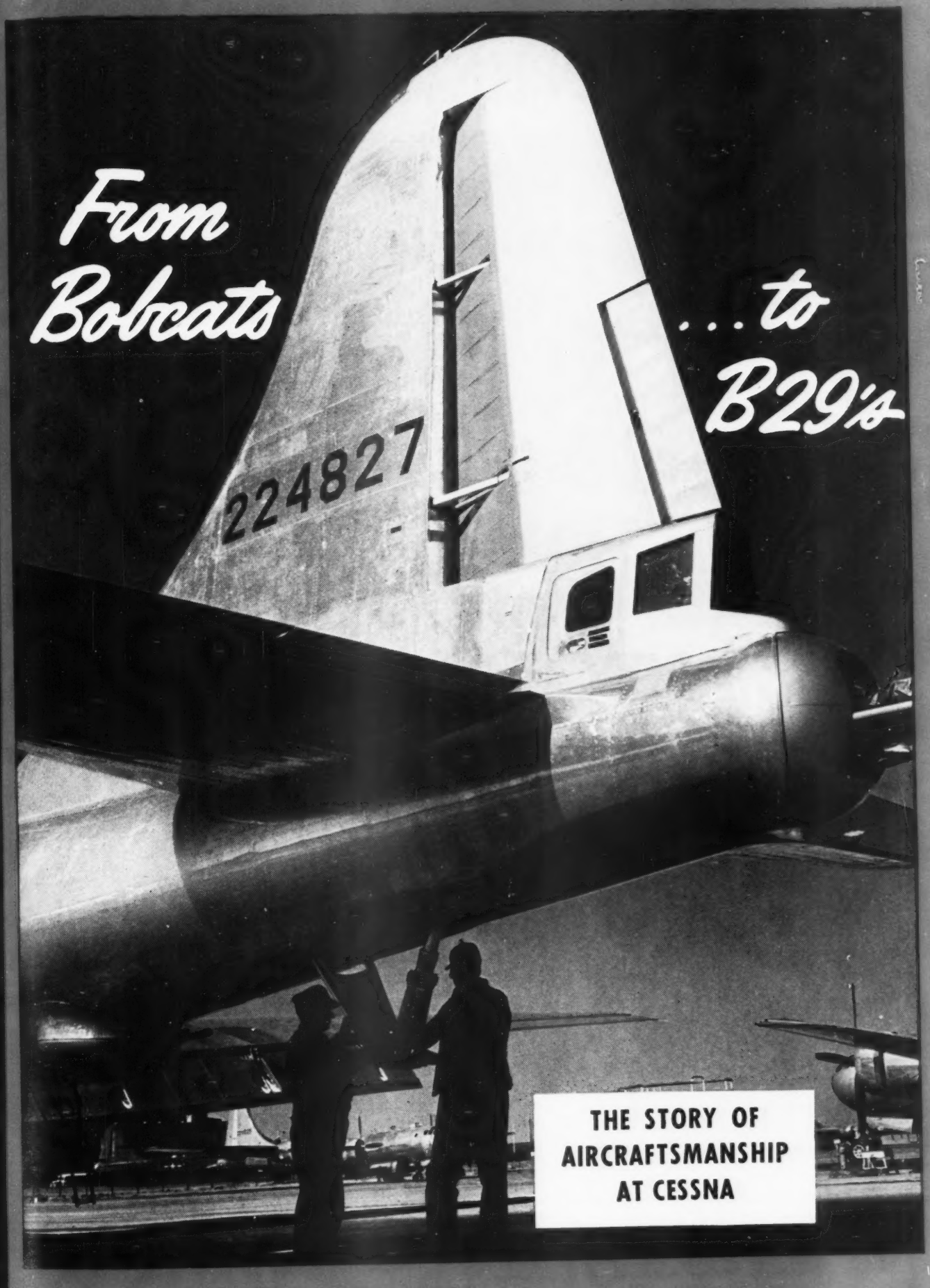
Specifications and Data

Wingspan	43 ft. 10 in.
Length	32 ft.
Height	10 ft. 4½ in.
Tread	12 ft. 4 in.
Wing area	240 sq. ft.
Gross weight	4,200 lb.
Empty weight	2,500 lb.
Top speed (sea level)	181 mph.
Cruising speed (sea level)	165 mph.
Stalling speed (sea level)	57 mph.
Climb (sea level)	1,740 fpm.
Service ceiling	24,400 ft.
Ceiling (one engine)	11,500 ft.
Range	700 mi.
Fuel capacity	80 gal.
Seats	5-6
Power plants	Two 190-hp. Lycoming 6-cyl.
Propellers	Two-blade automatic type, 6 ft. 6 in. dia.
Price	Est. $12,500 and up

Avro Grooms Lincoln Super-Heavy For Stepped-Up Hammering of Japs



NEW BRITISH super bomber, Avro Lincoln, as conceived by AVIATION staff artist, indicates this new addition to Allied air power bears a great resemblance to famed Lancaster but is much bigger. Designed for Pacific operations, craft is in same category with Boeing's Superfortress and is reported powered by Rolls-Royce Merlin engines. Wingspan is believed to be about 120 ft. and gross weight between 100,000-125,000 lb. In comparison, Lancaster III has span of 102 ft. and grosses 60,000 lb. Publicized good flying qualities and load carrying ability of "Lanc" probably influenced continuance of basic design for Lincoln.



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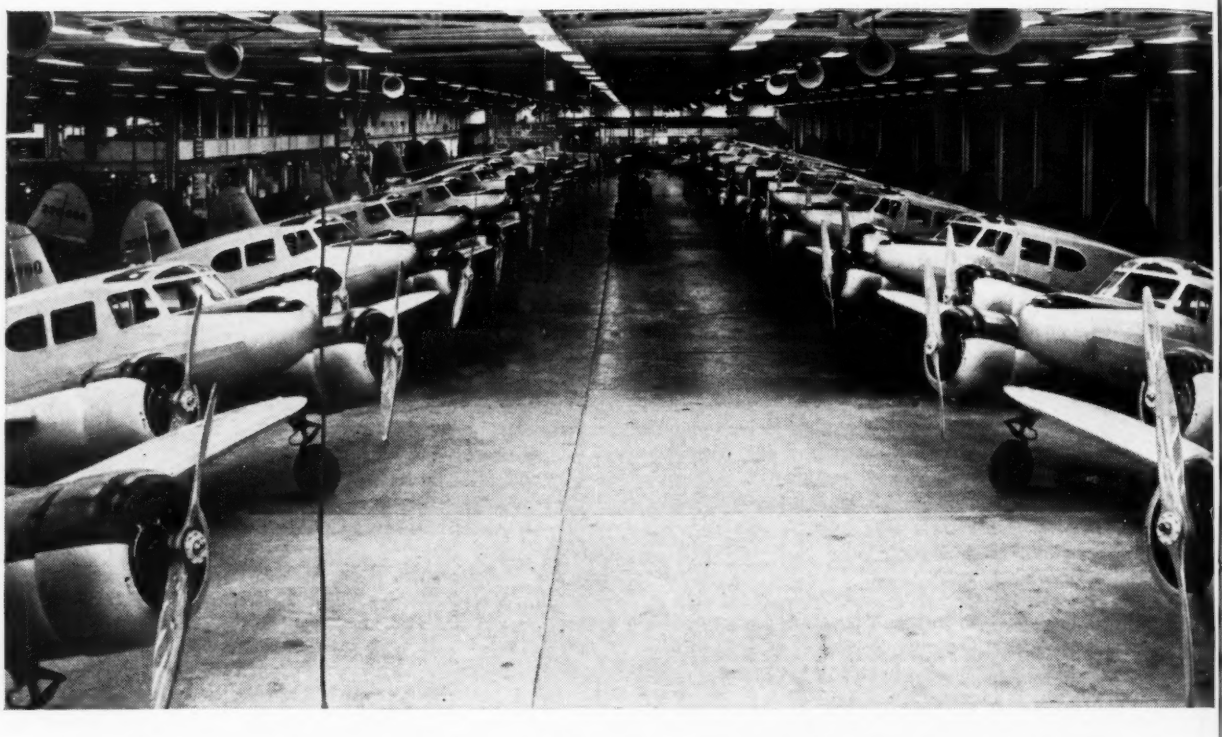
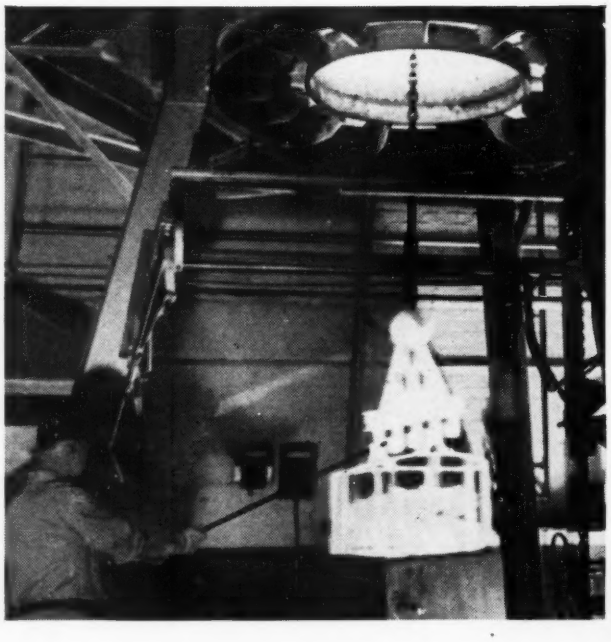
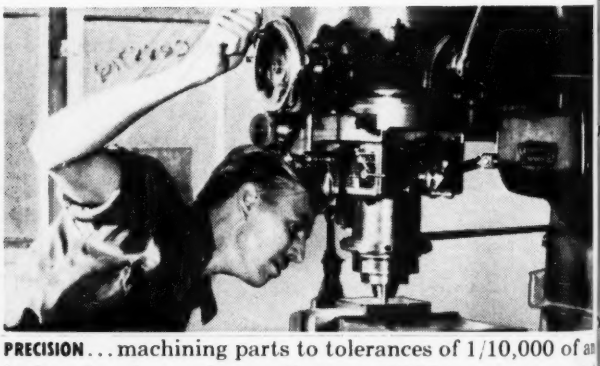


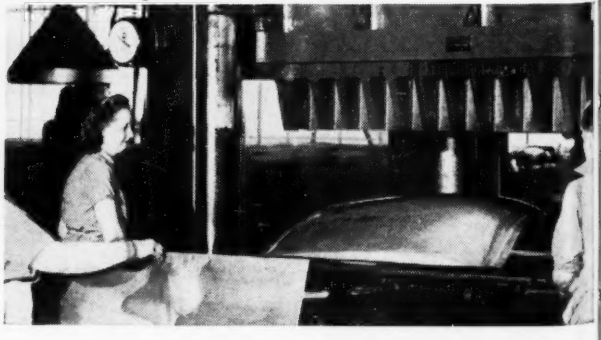
THE BOBCAT PRODUCTION LINE....



HOT SPOT . . . where metal parts of Superforts and Invaders are heated at 1700 degrees Fahrenheit.



PRECISION. . . machining parts to tolerances of 1/10,000 of an inch or forming engine cowlings on a 2500 ton press, metal craftsmanship is a science at Cessna.



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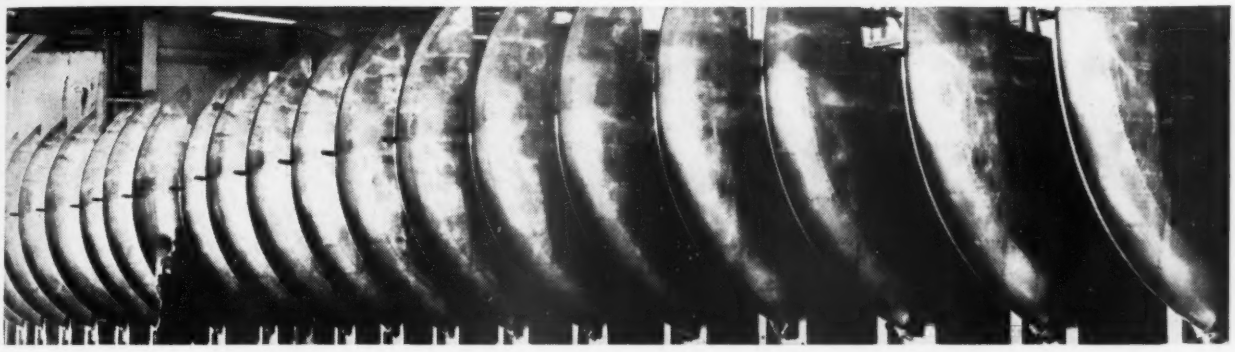
TO CESSNA.... *a "Natural!"*



...now builds heads for Douglas Invaders and tails for Boeing Superfortresses!

Thirty-four years of aircraftsmanship at Cessna is not just that many years of manufacturing airplanes. It is thirty-four years devoted to research, engineering, experiment and progress. What seemed to the world a miracle of transformation from peacetime private planes to all-out production of parts for giant B 29's was a natural accomplishment for Cessna.

When war came, the Cessna T 50, the famous twin-engine Bobcat, had already been acclaimed by America's private fliers. Its single-engined sister plane, the Cessna Airmaster had been three times proclaimed the world's most efficient airplane.

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Serving Through Science

D. H. PUSHES CONSTRUCTION ON NEW DOVE FEEDERLINER

Bearing a resemblance to Mosquito fighter-bomber, tricycle-gear all-metal light transport is designed to accommodate eight to eleven passengers. And it's an all-D. H. product, since company is supplying engines and propellers as well as airframe.

NOW UNDER CONSTRUCTION and scheduled to make its first flights sometime this year is the DH-104 Dove, a new feederline-type transport by Britain's de Havilland Aircraft Co. It is stated that the Dove will have first priority in the company's postwar commercial program, hence production will begin as soon as conditions permit.

A transport development of the famed D. H. Mosquito fighter-bomber, the Dove will be of all metal construction, with stressed skin covering, and it will feature a retractable tricycle landing year. Two supercharged D. H. Gipsyqueen six-cylinder in-line engines will be equipped with new type D.H. three-blade constant-speed feathering propellers. These airscrews will incorporate reversible pitch blades to aid in braking after landing.

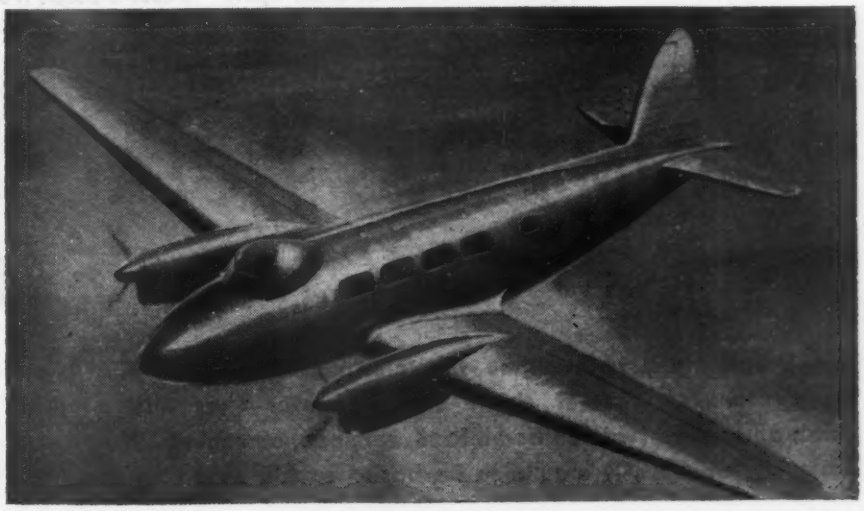
Since the new craft has been designed to serve small branch lines, charter traffic, executives, and for personal pilots, various cabin interiors are planned. It is stated that as a transport the ship will normally carry eight passengers and a crew of two, with inclusion of lavatory accommodation, fore and aft freight compartments, dual controls, and radio layout. Other variations include seating for ten passengers without a lavatory, or eleven seats if the aft luggage compartment is also eliminated.

Normal range is to be about 500 mi., and the craft will weigh about 8,000 lb. loaded.

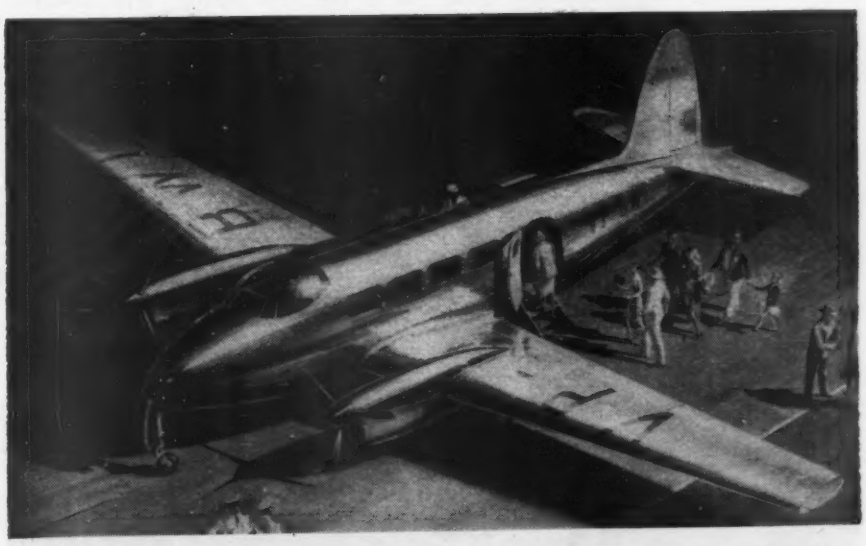
This will be de Havilland's second all-metal transport, the first was the prewar Flamingo, which was somewhat similar to the Douglas DC-5. It is now being used by the RAF as a light transport.

Specifications and Data

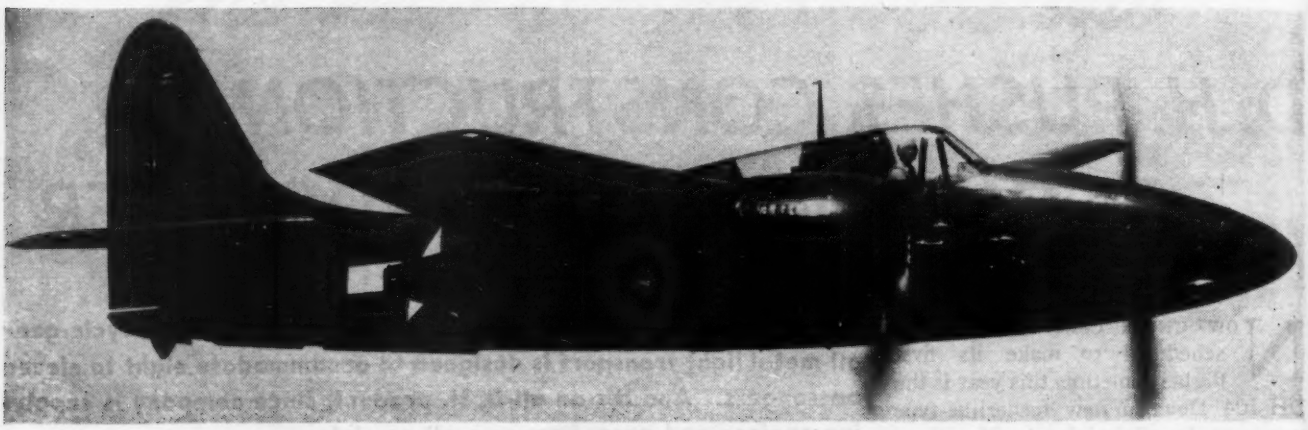
Span	57 ft. 10 in.
Length	39 ft. 3 in.
Height	12 ft. 6 in.
Range	approx. 500-mi.
Gross weight	approx. 8,000-lb.
Passengers	8–11
Crew	2
Power	2 D.H. Gipsyqueen 6-cyl. supercharged in-lines
Propellers	2 D.H. three-blade constant-speed feathering reversible pitch



Artist's conception of de Havilland Dove transport in flight shows craft's marked resemblance to Mosquito fighter-bomber. New craft is to be of all-metal construction with stressed skin covering, and power plants will be D.H. Gipsyqueen sixes, fitted with D.H. three-bladed feathering and reversible pitch propellers. A crew of two and from eight to eleven passengers are stated to be capacity.



Featured on D.H. Dove will be a retractable tricycle landing gear. Plane has been designed for use by feederlines, charter operators, executives, and also for personal pilots. Gross weight will be about 8,000-lb., and range approximately 500 mi. Planned are freight compartments fore and aft. Prototype, now under construction, is expected to be flying some time this year.



Grumman F7F Tigercat in flight gives an impression of pointed deadliness. Most powerful and heaviest armed fighter plane now in service, it has a stated top speed of well over 400 mph. and cruising radius of 1,500 mi. Engines are P&W R-2800-C Double Wasp at 2,100-hp. each, equipped with water injection and ejector exhaust stacks. (Official U.S. Navy photo)

GRUMMAN'S TIGERCAT FIGHTER IS NEW JAP HEADACHE

In 425-mph. class, twin engine, tricycle landing gear F7F 'Cat is our Navy's largest, fastest single seater fighter—has mile-a-minute climb and packs two-ton bomb load, torpedo, or rockets. Now being flown by Marines, it may also be based on big new carriers.

OUR NAVY'S LATEST AND LARGEST fighter plane, the Grumman F7F Tigercat, is now in production for U. S. Navy and Marine air groups. Although the Marines have been getting initial Tigercat production these planes also may be operated by Navy fliers from the new 45,000-ton Midway class carriers now coming off the ways.

This big new fighter plane is a departure from previous naval types in several ways. It is our Navy's first twin-engined single seater fighter, and the first to have tricycle landing gear. It is the first combat type designed from the start to perform a combination of duties—as fighter, long range escort fighter, bomber, strafer, torpedo-bomber, and night fighter (F7F-2N).

Powered by two Pratt & Whitney R-2800-C Double Wasp engines at 2,100-hp. each, equipped with water injection, ejector exhaust stacks, and Hamilton Standard three-bladed Hydromatic propellers, the Tigercat has a top speed in the 425-mph. class, at craft's critical altitude. Rate of climb is stated to be a mile-a-minute, and with a 300-gal. drop fuel tank range is considerably greater than either the Corsair or Hellcat, both of which have a cruising radius of 1,500 mi.

Construction is all-metal with stressed skin covering and the dark blue camouflage finish is highly polished, to bring skin drag down to a minimum.

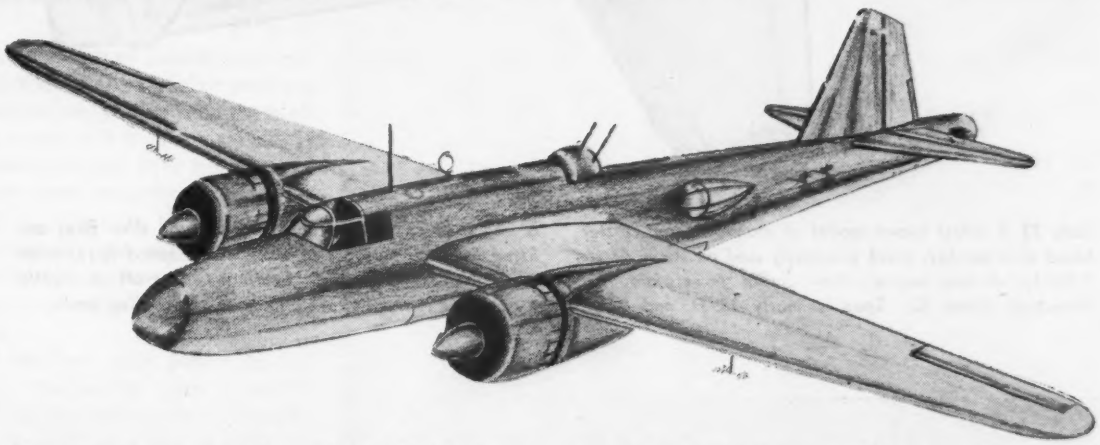
It is a big airplane, when compared with contemporary fighter craft, almost half again as heavy as the F6F Hellcat, which weighs about 7,000-lb. However, at a recent press preview, where the plane's flying qualities were demonstrated by a group of Marines and by Grumman's test pilot, the craft showed a remarkable ease of maneuverability at a wide range of speeds.

Firepower of the F7F surpasses that of any naval fighter now in action. In addition to heavy standard fixed armament, 4,000-lb. of bombs, or a full-size naval torpedo can be carried, or rockets, or rockets and bombs.

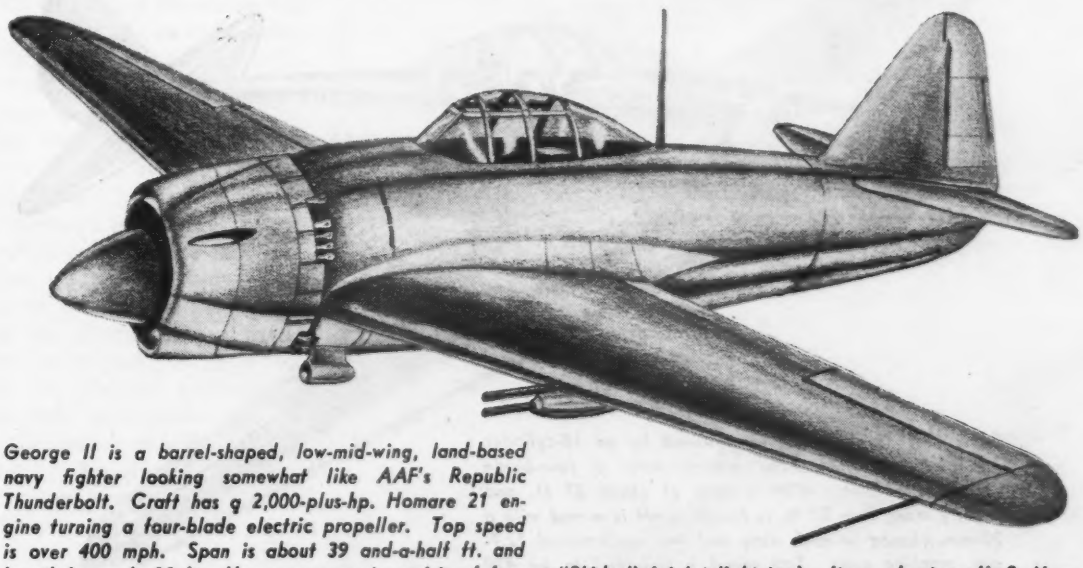
Tigercat's folding wings are hydraulically operated from cockpit. They are seen here in fully folded position and require no bracing bars. In leading edge of wing's center section are four air intakes, one on each side of each engine. (Photo by Aviation staff photographer)

NEW JAP WARPLANES

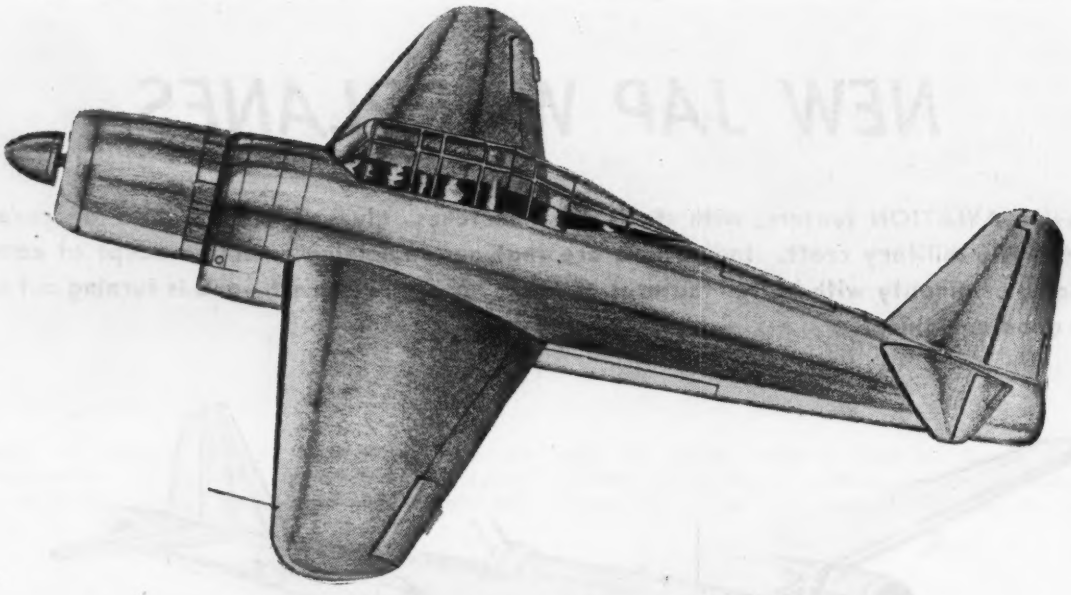
Exclusive AVIATION feature, with staff artist sketches, gives available data on recently spotted Nip military craft. Indications are that our remaining enemy is adept at combining some originality with better features of other nations warcraft—and is turning out some very good equipment.



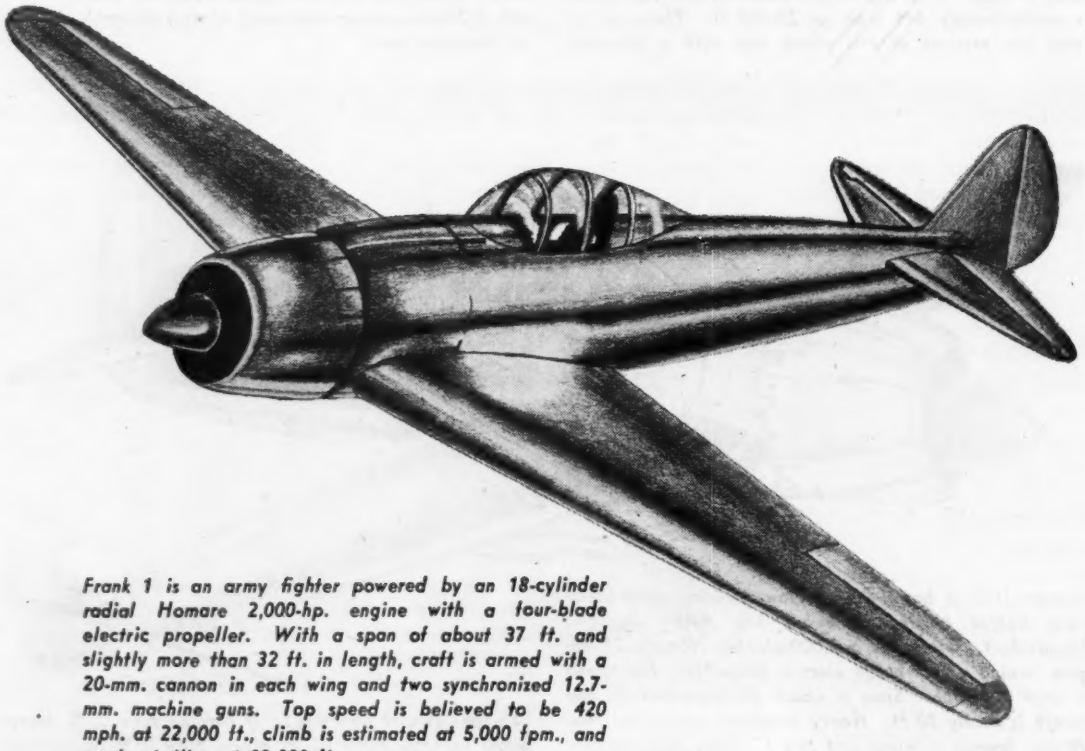
Peggy I is an army reconnaissance-bomber that looks very much like Betty and Helen. Powered by two unknown type radial engines, craft has full feathering propellers. Span is about 74 ft. and length about 61 ft. Top speed is approximately 345 mph. at 20,000 ft. There are at least two versions of this plane; one with a plywood-covered nose and tail cone, used for reconnaissance and search and fitted with radar; another type has conventional transparent nose and tail piece, for bombing operations. Craft has a hydraulically operated power turret with a 20-mm. cannon and waist blisters probably mounting machine guns.



George II is a barrel-shaped, low-mid-wing, land-based navy fighter looking somewhat like AAF's Republic Thunderbolt. Craft has a 2,000-plus-hp. Homare 21 engine turning a four-blade electric propeller. Top speed is over 400 mph. Span is about 39 and-a-half ft. and length is nearly 30 ft. Heavy armament consists of four 20-mm. cannon in wings and two 12.7-mm. nose machine guns. Engine is fitted with water injection device and has ejector type exhaust stacks. Japs call this plane "Shiden" (violet lightning). It may be type U. S. Navy pilots recently reported as giving them stiff opposition. Also reported in service is a single-float seaplane fighter version named Rex II.



Judy 33 is latest known model of standard Jap carrier-based dive-bomber, which previously used an Aichi Atsuta 1,150-hp. in-line engine. New radial powerplant is a Mitsubishi Kinsei 62. Span is nearly 38 ft. and length is about 34 ft. Retractable spoiler type dive flaps are fitted to under surfaces of wings. Top speed is reported as just over 300 mph. Seating two, craft is lightly armed and is not believed to have self-sealing tanks.



Frank 1 is an army fighter powered by an 18-cylinder radial Homare 2,000-hp. engine with a four-blade electric propeller. With a span of about 37 ft. and slightly more than 32 ft. in length, craft is armed with a 20-mm. cannon in each wing and two synchronized 12.7-mm. machine guns. Top speed is believed to be 420 mph. at 22,000 ft., climb is estimated at 5,000 fpm., and service ceiling at 39,000 ft.

For want of aero guideposts, flyers may be lost. And for want of flyers, the airport business may be lost. Answer lies in installation of a practical air marking system which will solve the landmark mysteries and make it easy to—

CHERCHEZ LA AIRPORT

By JOHN ABIUSO

A MUCH TRAVELED tourist once remarked, "When you've seen six mountains, you've seen them all because the rest will look the same". If he had been a touring flyer his remarks would have been even more emphatic, because it is quite easy to mistake one whole county for another, particularly when passing over parts of the country where easily recognizable landmarks are scarce.

In fine weather, with plenty of fuel in the tank, this kind of thing is merely annoying, but in rain or snow, inability to locate himself may cost a pilot his life.

Painted or concrete markers have often been used for the purpose of guiding flyers, as have signs on roofs of large buildings, but in snowy weather the painted ones are often obscured, and the common concrete ones are buried by a heavy snowfall.

To obviate this defect the author has designed a new type of elevated marker sufficiently high to prevent either drifting snow or sand from covering it. In sections where undergrowth springs up rapidly, this type of marker may be erected to a height overtopping the surrounding scrub.

General views of the marker at different stages of snowfall are shown in Fig. 1, 2, and 3. In the first photo, the snow is up to the bottom of the flat portion; in the second, it has partly covered the lower part; while in the third stage the vertical part of the sign is the only part visible, yet in every case the marker is still clear and unmistakable. The slatted construction prevents even wet snow from drifting over the top of the vertical parts,

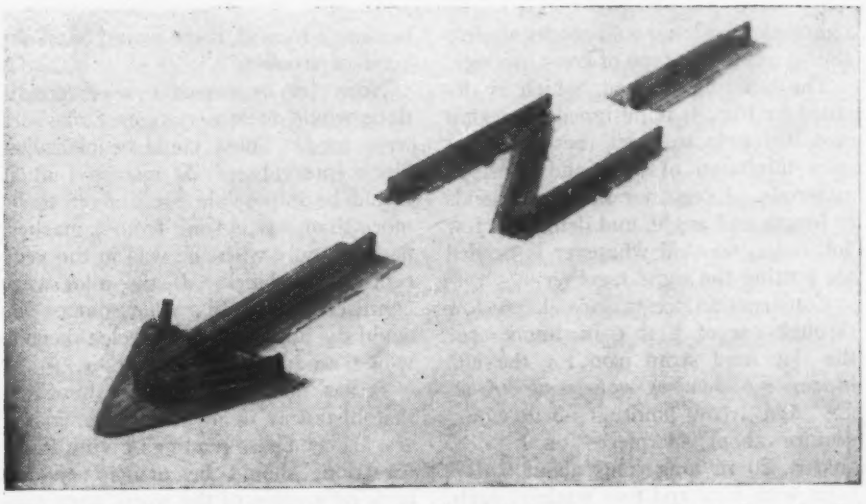


Fig. 1. Sign when snow is level with underside of horizontal slats. Patented construction enables marker to be seen even when snowfall has been heavy. Snow has been blown clear from flat surfaces.

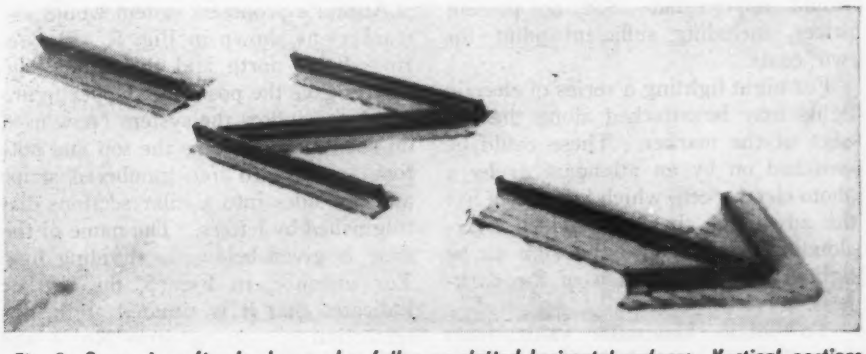


Fig. 2. Same sign after fresh snow has fallen on slatted horizontal surfaces. Vertical portions give good visibility.

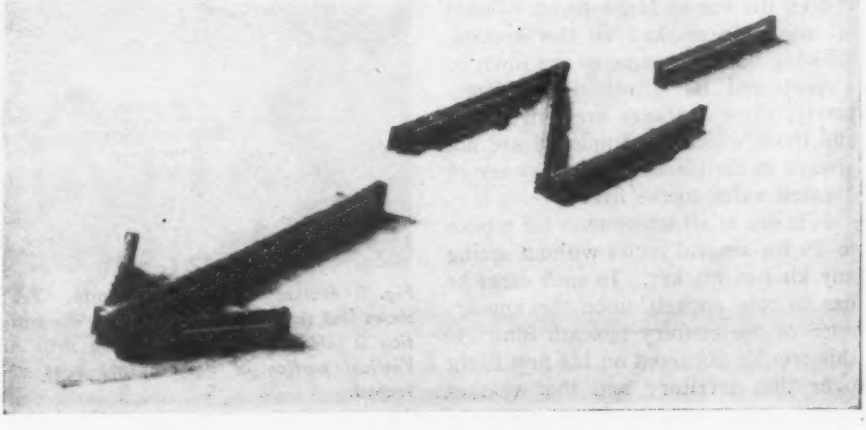
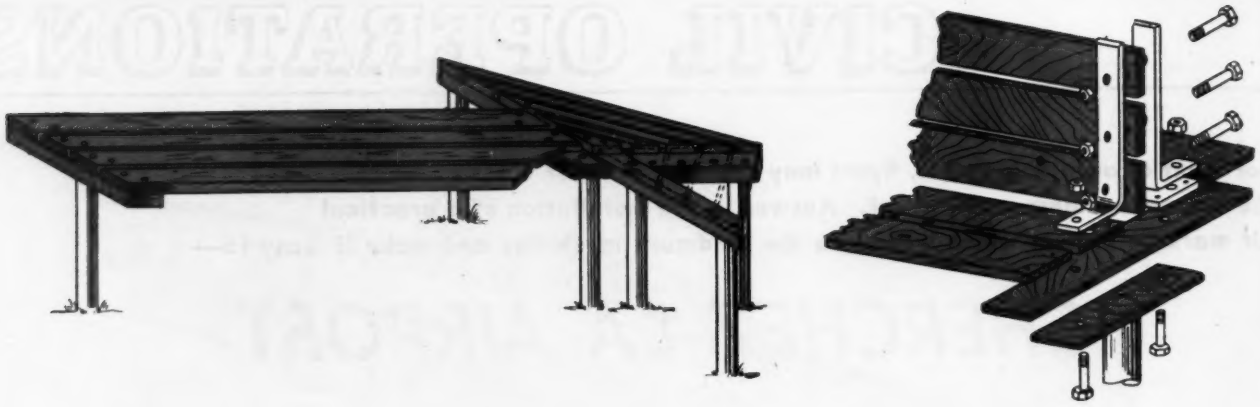


Fig. 3. After horizontal parts of sign have been entirely buried by snow, this sign will stand out and be visible for a long distance. Slatted construction allows snow to blow through vertical parts of sign instead of drifting against them and rendering them invisible.



a condition which would render useless almost any other type of construction.

The building method, which is detailed in Fig. 4, is designed to permit unskilled help to erect these markers in a minimum of time and of stock materials. Except for sawing the ends to length and angle, and drilling a few bolt holes, no skill whatever is needed for putting the signs together.

Construction costs are kept low through use of 1 × 6 in. lumber for the slats and strap iron for the end braces. A marker consisting of an "N" and arrow pointing north would require about 44 pieces of 1 × 6 boards, 20 ft. long, plus about 6 doz. bolts with nuts and two washers each. Two dozen posts, long enough to project 3 to 3½ ft. above ground level would also be required. Total cost would approximate $28 at present prices, including sufficient paint for two coats.

For night lighting a series of electric lights may be attached along the top edge of the marker. These could be switched on by an attendant or by a photo electric cell, which latter plan has the advantage that any sudden overclouding would cause the sign to be lighted for the duration of the darkness.

To obtain maximum value from these devices, it would be necessary to employ them according to same universal system. CAA has already advanced the use of large signs, painted on roofs or marked on the ground, showing both the name of the town or airport and its direction. Unfortunately, these markers are infrequent, and those which are employed are not always in the places where they are of greatest value to the flyers.

It is not at all uncommon for a pilot to fly for several hours without seeing any kind of marker. In such cases he has to rely entirely upon the appearance of the country beneath him. If this trouble occurred on his first flight over that territory and the weather became a hazard, there would be likelihood of trouble.

Now, let us consider what conditions would be if a system of markers were used. These could be placed at block intervals of 20 mi. so that it would be impossible for a flyer to be more than, say, 14 mi. from a marker, and this only when he was in the very center of a block. If the pilot were confused as to his whereabouts, he could fly in a widening circle; then he would readily locate a marker.

It has been proposed by the CAA that distances of airports from markers, also compass readings giving flight direction, should be printed on the back or margin of the maps, thus saving much computation at a time when the pilot might be busy locating himself.

Author's proposed system would use markers as shown in Fig. 5. The arrow shows north and the letters and figures give the position. Upper figure and letter follow the system (now used on road maps) where the top and bottom are divided into numbered strips and the sides into similar sections distinguished by letters. The name of the state is given below the dividing line. For instance, in Fig. 5, the marker indicates that it is situated at the intersection of vertical strip No. 7 and horizontal strip Letter A in the state of Pennsylvania. By referring to the list of distances on the margin of the map, the pilot would find the distance and compass direction in degrees to the nearest airport.

Fig. 5. Marker arrow indicates north. "PA" shows that sign is in Pennsylvania, while position is intersection of strip 7 with strip A. Vertical portion of sign has not been attached.

Method devised by CAA is similar, except that it uses latitude and longitude readings. This is excellent for the man who is familiar with the use of charts for plotting courses, but this method may be somewhat unwieldy for a new pilot who has served many years apprenticeship in road map reading.

Objection has been made to general use of markers on the score of high cost, but this is a fallacy. When benefits are balanced against cost of installation and upkeep, a national air marker system would be one of the cheapest forms of pilot life insurance ever proposed.

Let us take a specific state—Pennsylvania. It is neither the largest nor the smallest, having an area of about 45,000 sq. mi. To lay out the entire state would require less than 200 markers. Some states would require more, others less; but this is a good average. Each marker serves 20 × 20 mi., or 400 sq. mi. so that 7,500 markers would suffice to give coverage for the entire United States.

Built and shipped in quantities, markers would not cost over $20 per letter, in place, or a total of $600,000 for all 48 states. This is the cost of about 30 mi. of ordinary first class highway. As compared to the more than $97,000,000 of Federal road expenditures during a recent year, the cost of national air marking is about 1½ percent. No other movement of such national importance and benefit would cost so little.

In the event that the CAA proposed system, using latitude and longitude, were used, the cost would be doubled, due to the larger number of letters, but even then it would not be heavy, as national public works expenditures go.

As a comparative figure, the Federal Government expended in 1942 the sum of $19,500,000 for elimination of railroad grade crossing hazards, a sum sufficient to install markers throughout the country at less than 10 mi. intervals. So the question of cost cannot be considered as a valid objection.

The system advised by CAA is shown in Fig. 6, and both methods of marking are compared on the map presented in Fig. 7. Each has advantages and disadvantages not possessed by the other, but it is likely that the inexperienced flyer—that is, the average plane owner—would prefer reading four letters rather than eight, especially if he were attempting to locate himself on the map at the same time.

There are several advantages in using a marker which shows the name of the state over which the plane is traveling. First of all, because a pilot may fly from one of the smaller states to another without knowing it, if the weather is cloudy, it is a distinct advantage to him if he can make sure that he has to use another map rather than the one with which he started. Unless one is flying over fairly familiar territory, merely knowing latitude and longitude is no index to the map which should be used. There are several localities in this country where three or four states come together, or are so close that it is quite possible to pass over all of them in less than half an hour. Since state lines are not marked for indentification from the air, some means is required whereby the pilot may make sure that he really is flying where he believes he is.

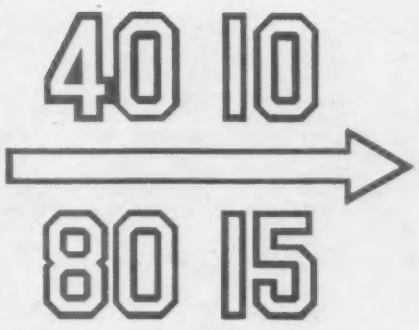


Fig. 6. Standard CAA marking shows latitude at top and longitude at bottom.

In addition, markers which carry state identification have a great advertising value. They serve as a constant reminder to the flyer that he is passing over a district where there may be places of interest worth stopping to visit. Resulting extra business should more than pay for the cost of the sign within a short time

Though the preceding description has been written on the assumption that the markers would be built of lumber, many other materials might be used. One large steel manufacturer already has been experimenting with enameled steel for this type of sign, and this firm appears satisfied with the results. Advantages of prefabricated units would be in cheapness of erection, but against this factor would be a much higher freight rate for the units and the cost of protective packing, both greater than in the case of lumber. A well painted lumber sign, properly maintained, should last as long as a well painted building of the same material. There are hundreds of centenarian houses made of lumber—houses still in excellent condition—so the obsolescence of the wooden sign should not be a matter of material so much as a matter of care expended in its maintenance.

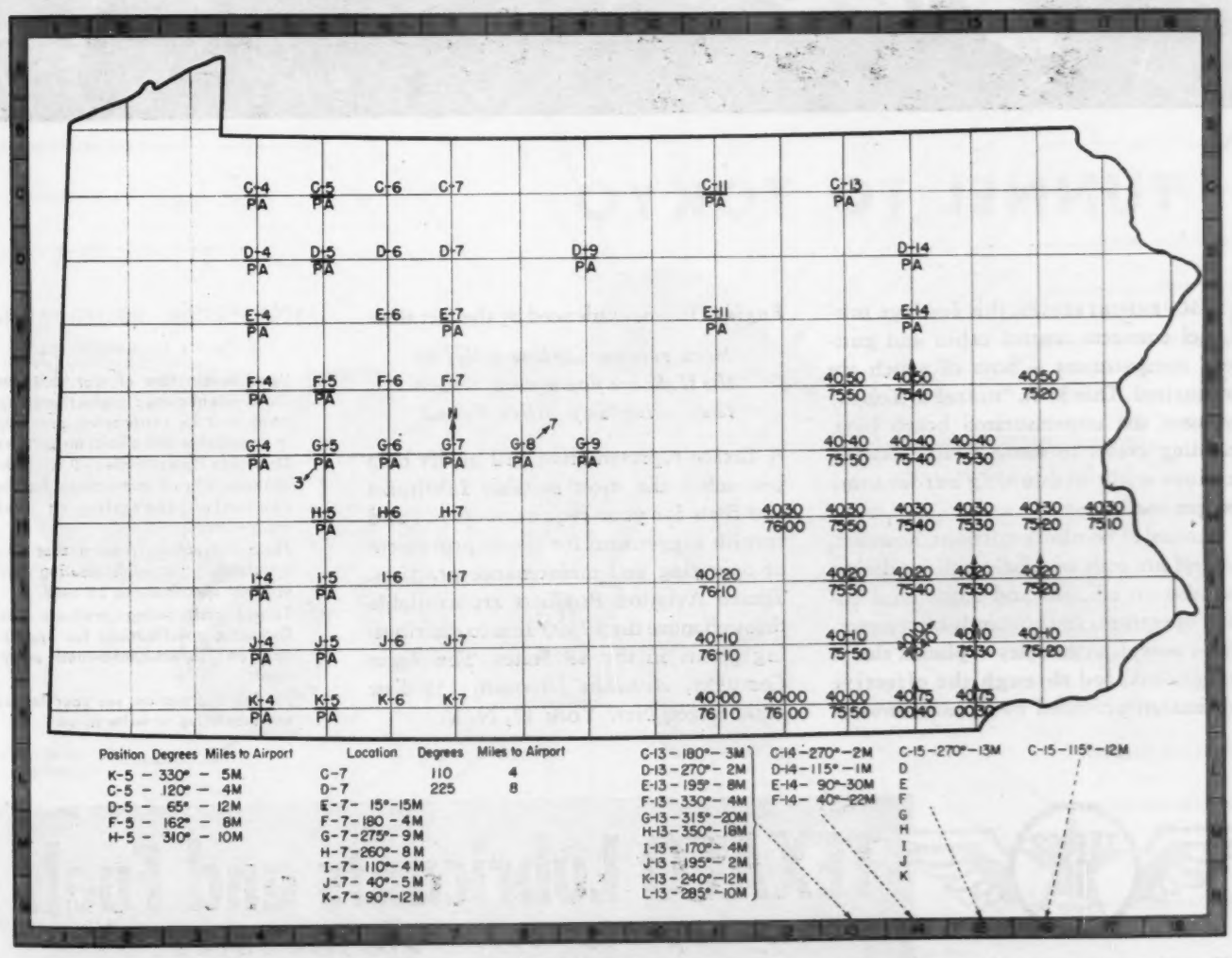
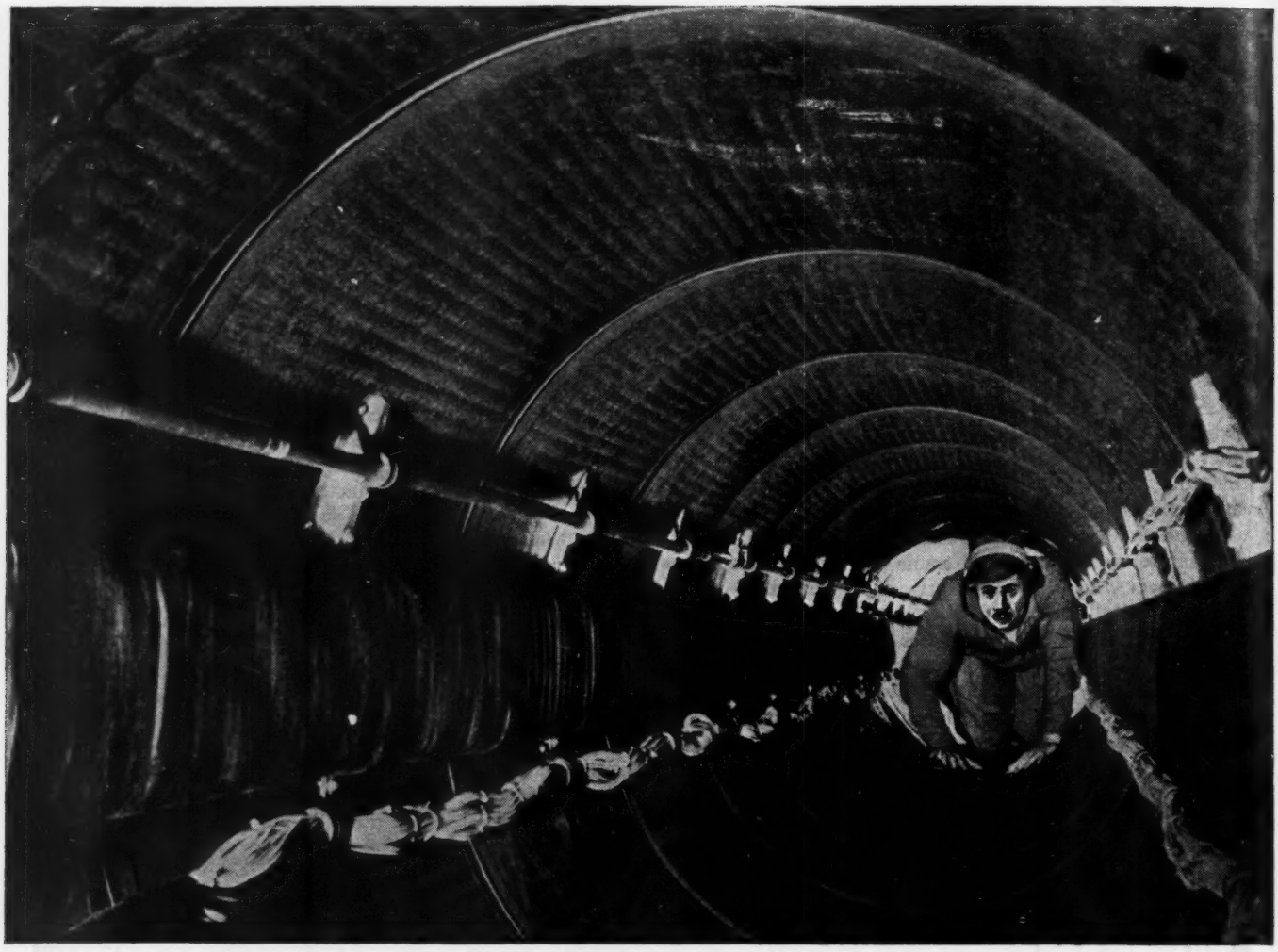


Fig. 7. Map of Pennsylvania with CAA markings system at right and author's proposed system at left. Specimens of directional figures are given at top of map, showing distances to nearest airports from different intersection markers.



TUNNEL TO TOKYO

IN SUPERFORTRESSES, this fuselage tunnel connects control cabin and gunners' compartment — both of which are pressurized. This 35-ft. "tunnel to Tokyo" bypasses the unpressurized bomb bays, enabling crews to move freely between sections without donning burdensome oxygen masks.

Successful bombing missions, however, depend not only on efficient plane design but also on efficient and economical engine operation. In thousands of commercial — as well as military — planes, this is largely assured through the effective lubrication provided by *Texaco Aircraft Engine Oil*—as evidenced by the fact that:

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RECONVERSION RUSTPROOFING

5 Points to Remember

1. Upon termination of war contracts, Government-owned production equipment must be rustproofed promptly, in accordance with *official instructions.*
2. Ordnance Specification P.S. 300-4 contains *official instructions* for the complete processing of such equipment.
3. These instructions require that only rustproofing materials meeting Government specifications be used.
4. *Texaco rustproofing products meet Ordnance specifications for application on Government-owned equipment.*
5. For full information, see your Texaco representative or write to us.

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INSPECTION AND SERVICING OF AEROMATIC PROPELLER

PART I

Detailed here in picture form are steps for efficient checking and maintenance of Koppers Co. automatic propeller designed for small and medium-size aircraft.

THE AEROMATIC PROPELLER, made by the Koppers Co., Bartlett Hayward Div., Baltimore, adjusts its blade pitch automatically through reactions caused by centrifugal forces and propeller thrust.

Since each throttle setting or change in manifold pressure causes a different thrust, and because the centrifugal forces, which tend to turn the blade, vary with the rpm., each combination of these forces results in a slightly different position of the blades. In other words, operation of this airscrew is via varying forces which are always present during flight, instead of by mechanical pitch-changing means.

Time lag is extremely small because no governor reaction is necessary prior to direct action on the blades.

Maintenance and replacements have been kept to a minimum through the simplicity of the design, which required only one major moving part besides the blades. Since the forces causing change of pitch are restricted by the weight and rpm. of the propeller, it is essential that lubrication, clearances, and adjustments be given close attention. When these factors are cared for, satisfactory action in flight is automatic.

(Turn page for illustrative figures)

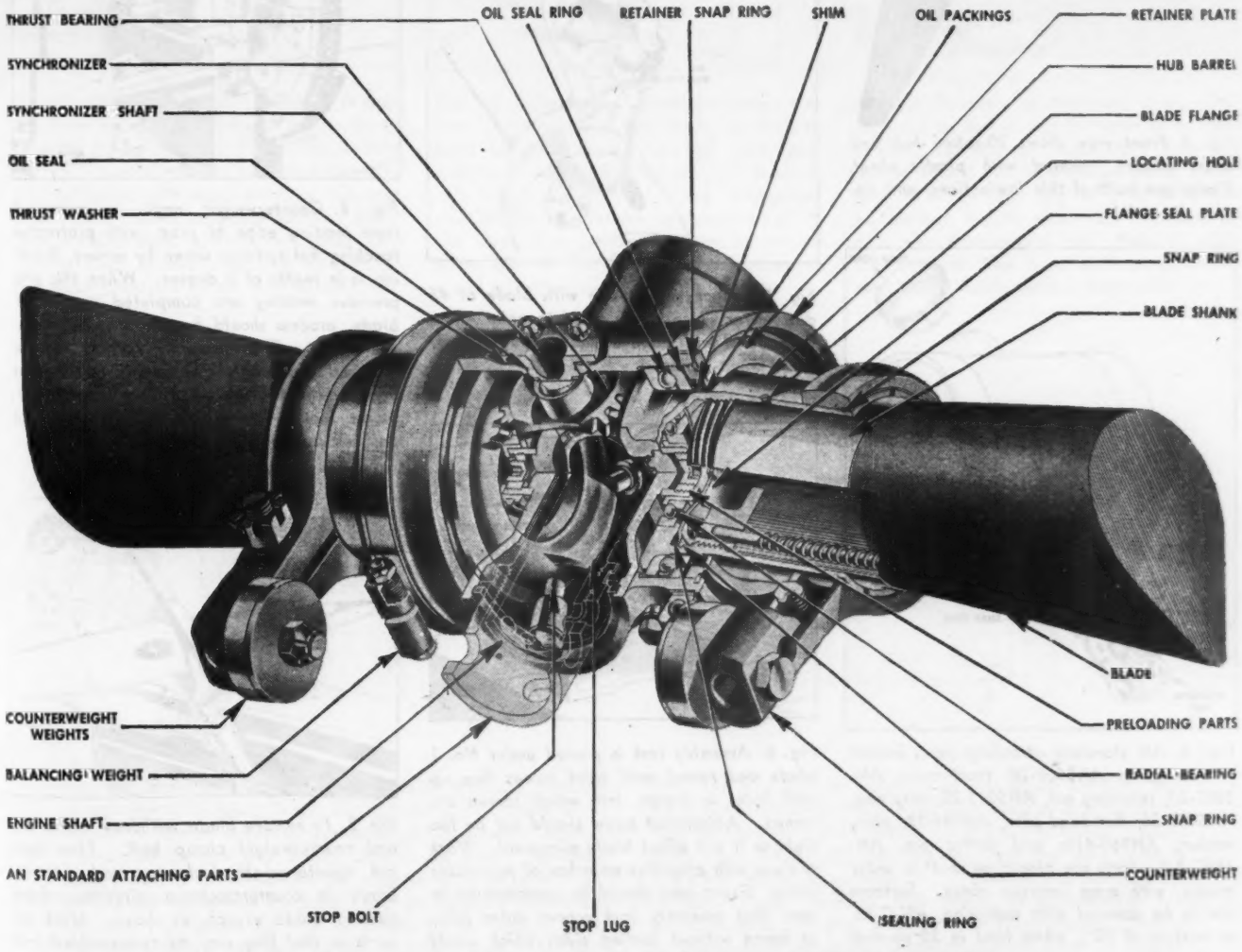


Fig. 1. Cutaway front view of Aeromatic propeller shows simplicity of construction.

Fig. 2. Front view shows 20-spline hub and offset blades, covered with plastic sheet. Blades are built of thin laminations, and tipping is metal.

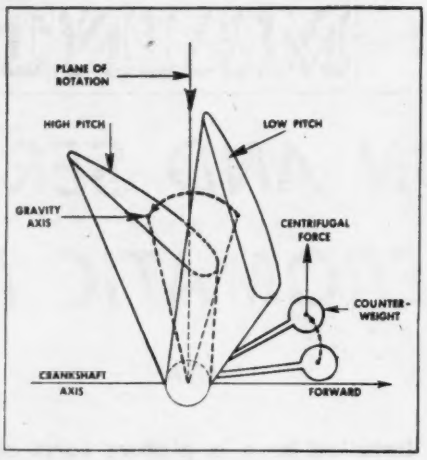


Fig. 4. Forces acting to move blade. Centrifugal force of blade tends to move it into line with plane of rotation. Thrust against working face would push blade forwards into low pitch. Counterweight tends to move blade into high pitch position. Balance between these three forces results in blade moving to correct pitch for each combination of forces. Changing of position of counterweights at assembly will result in changed pitch for same working conditions.

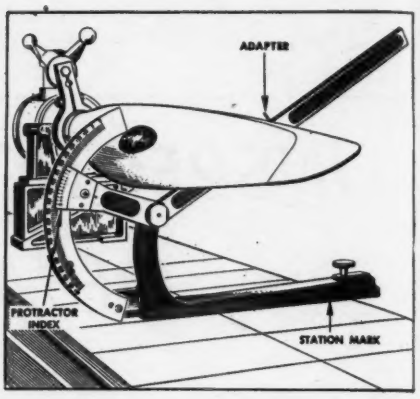


Fig. 7. Phase angle is measured at 36 in. radius station, with adapter between blade and protractor. A magnifying glass should be used for this work, reading being taken in tenths of a degree.

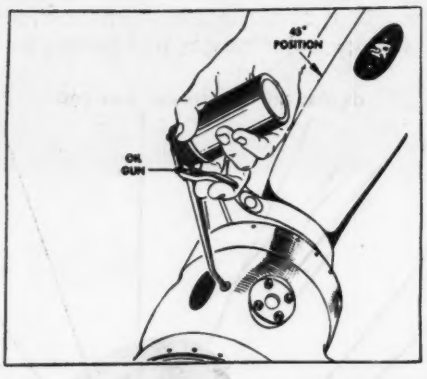


Fig. 5. Oil check is made with blade at 45 deg., after which hub is filled to point where oil is level with edge of hole. Plug is lockwired when replaced.

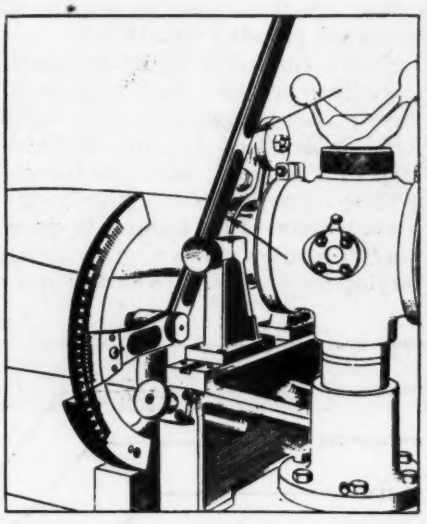


Fig. 8. Counterweight angle is measured from leading edge of prop, with protractor touching flat surfaces shown by arrows. Reading is in tenths of a degree. When this and previous reading are completed on No. 1 blade, process should be repeated on opposite blade. Then assembly fork should be removed and angles measured with blades against high and low pitch tops, respectively. Blade should be supported in low pitch position by means of padded blocks.

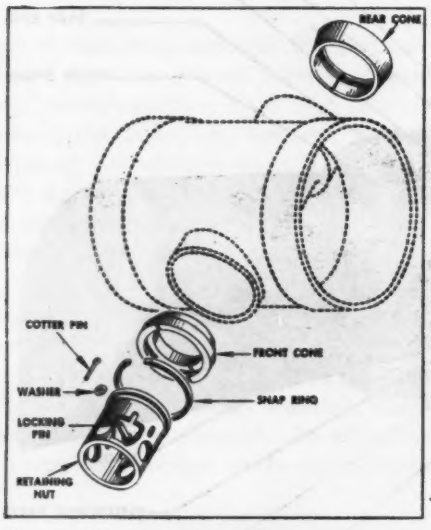


Fig. 3. AN standard attaching parts consist of rear cone, AN5008-20; front cone, AN-5007-20; retaining nut, AN5011-20; snap ring, AN5009-20; flat head pine, AN394-19; plain washer, AN960-416; and cotter pin, AN-380C-2-3. Parts are placed on shaft in order named, with prop between cones. Surfaces are to be covered with anti-seize, AN-C-53, or mixture of 70% white lead in 30 percent engine oil.

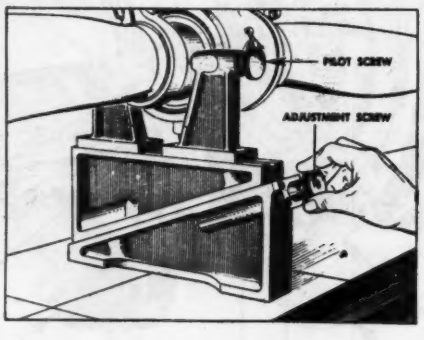


Fig. 6. Assembly fork is placed under No. 1 blade and raised until pilot screws line up with holes in flange, into which screws are turned. Adjustment screw should not be too tight or it will affect blade alignment. Work is done with propeller on arbor of protractor table. Great care should be exercised to insure that assembly fork screws enter holes in blade without fouling sides which would cause misalignment of blade.

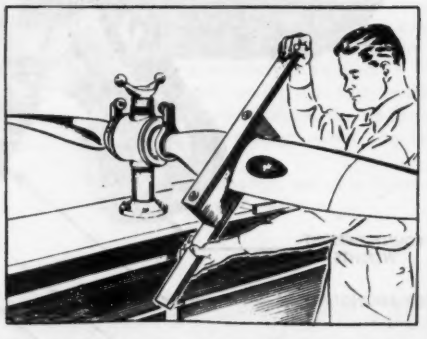


Fig. 9. To remove blade, withdraw cotter pin and counterweight clamp bolt. Then take out counterweight lockscrew and unscrew blade in counterclockwise direction, using padded blade wrench, as shown. Mark all parts so that they may be re-assembled into same blade.

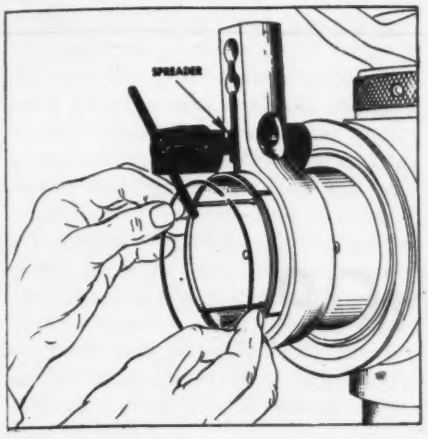


Fig. 10. Removal of counterweight is accomplished by sliding it back far enough to permit removal of snap ring in end of flange after which weight may be slipped off. Spreader may be used if weight is tight.

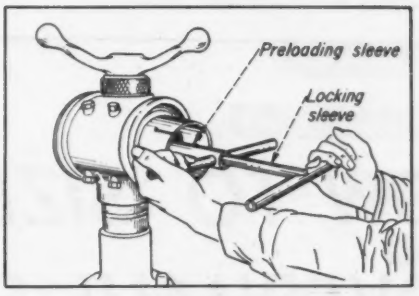


Fig. 12 (above) and Fig. 13 (right): Insert preloading tool (which has a toothed tubular outer part to fit preloader sleeve and hexagon center piece for Allen pipe plug which expands and looks sleeve) through clamps and loosen pipe plug while holding sleeve from turning. Turn preload sleeve all way in and remove snap ring with tool (Fig. 13). Keep oil pan under barrel at this time. Count and remove shims along with packing retainer, oil seal retaining ring.

and oil packings. Remove oil seal ring first to prevent damage. Remove flange and thrust bearing.

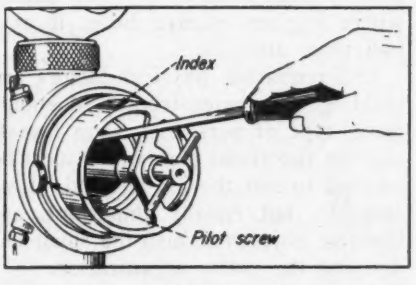


Fig. 11. Flange seal plate retains oil in hub, therefore a receptacle should be employed to catch oil before removing plate. To take out plate, install flange seal ring assembly tool on flange, with index marks on top, and secure pilot screws in flange-locating holes. Turn handle until plate clears snap ring groove, then remove ring with screwdriver and take plate out when tool is detached.

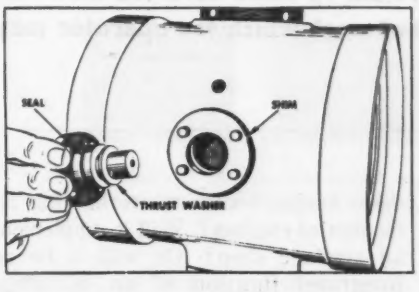


Fig. 14. After second flange has been taken apart, remove four nuts from synchronizer shaft flange studs and take out shaft, seal, and thrust washer, holding all parts from inside hub to prevent their falling. Laminated shim should be carefully removed from studs. On reassembly, laminations may be peeled from shim if gear clearance adjustment is found to be needed.

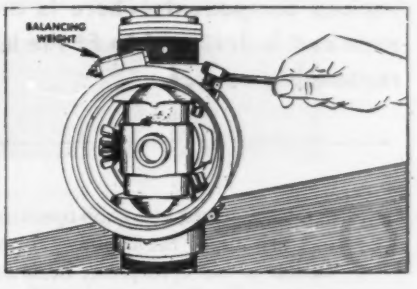


Fig. 15. Remove stop bolts and shims, marking each so that it will be returned to same position for correct assembly. Balancing weight should not be removed unless necessary, in which case original position should be marked before removing. Remove oil filler plug from side of hub. Keep all parts covered and free from dust or grit, and wash immediately before reassembly.

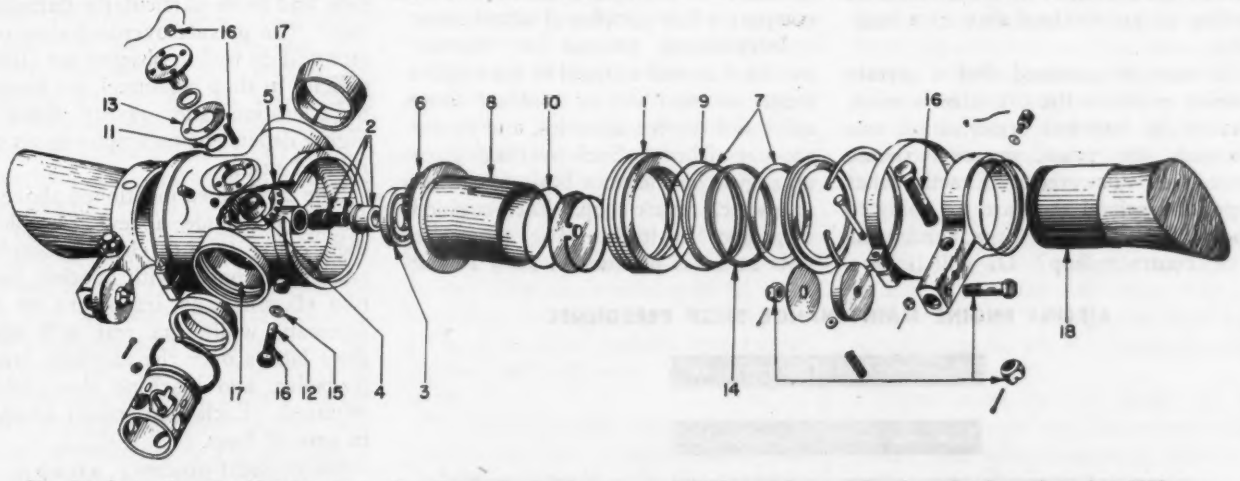


Fig. 16. Inspection should take place after thorough cleaning in gasoline or cleaning fluid. Thrust bearing (1) should show no rust or broken surfaces. Preloader (2) and radial bearing (3) should be free and bright, showing no cracks. Synchronizer gear (4) bushing should not show visible wear, and teeth on (5) and (6) should be smooth and serviceable. Flange oil packings (7) should be free of feathering or breaks, while contacting flanges (8) must be smooth. Seal rings (9), (10), and (11) must have no breaks or feather edges, but (10) may be slightly flattened without harm if surface is undamaged. Ends of stop bolts (12) should be in good condition. Shims (13), (14), and (15), also threads (16), and cone seats in hub (17), should be undamaged. If ferrule head screws (18), in table shanks, are loose, they should be tightened to 110 in./lb. torque. All steel parts must be Magnafluxed. Details of reassembling Aeromatic propeller will be given in August.

HOW TO "SIZE" THE OVERHAUL SHOP

PART VI OF A SERIES

By E. F. LINDSLEY

Success of a business organization depends on proper balance of its various components—here is a formula to make sure the maintenance end is designed to fit the kind of work which the operator may reasonably expect.

ONCE THE OVERHAUL shop operator has organized the business foundation of his enterprise, he must turn to the task of analyzing and organizing its working. Here, there are several well defined patterns. Continuous-flow, mass production methods, intermittent process, custom shop procedures, supplements to airplane shops or sales organizations—all have a place. In the case of an airline, it is found that the most logical plan is better defined than it is for a man bent on setting up an overhaul shop as a business.

It must be assumed that a certain market exists in the organizer's mind. Before the business organization was planned, one prime question should have been answered: "Exactly what type of overhaul shop are we going to operate? Will it be a large, continuous flow, contract shop? Or will it be a more modest business, overhauling all manner of engines? Will it supplement an airplane shop? Or will it be an integrated function of an operating organization, as with an airline or charter service?" The answers are vital. Only when the program is thoroughly understood by all concerned is it time to start on the shop plans.

In order to fix clearly the distinctions between continuous-flow and an intermittent-overhaul operation, let us examine the characteristics of each and compare a few samples of actual shops.

Intermittent process or "custom" overhaul is well adapted to the requirements of most job or contract shops, sales and service agencies, and moderate-size airlines. Such overhaul places an engine on the same basis as a watch in a watch repair shop. Each engine is a project in itself. The continuous flow or mass production shop is suitable for agencies undertaking a large number of overhauls on similar engines; for instance, the very large airline, military overhaul depot, or extremely large contract overhaul station where engines receive little, if any, individual attention.

Differentiating physical factors are building size, extensiveness of equipment, type of personnel, shop layout, and the functional plan which must be selected to suit the job at hand. Less tangible, but equally important, are business objectives, also the spirit underlying the entire organization.

A typical intermittent-process overhaul shop will handle 100–150 overhauls per year on engines of about 1,200 hp. This will be accomplished by a total shop force of 20–30 men. In this last item, shop personnel, may be found a key to the supremely fine work and amazing efficiency that have characterized airline maintenance both before, and more particularly during, the war. The private overhaul shop operator will do well to observe the airline's policies in shop personnel, for economy of operation and quality work are highly dependent on employee versatility and skill.

The 20–30 men mentioned above will normally include a few who devote their entire time to cleaning airplanes and engine parts, with another one or two classified as inspectors or shop foreman, while the rest will spread their labors over the airplane, engine, propeller, and machine shop jobs as required. Each man should be expert in several lines.

Intermittent-process shops are further distinguished by their equipment, and tied in with this, their functional setup. Any shop is interested in saving labor and time, but sound economics do not always call for extensive conveyor lines, automatic industrial washing machines, huge machine shops, and the subordination of

AIRLINE ENGINE MAINTENANCE SHOP PERSONNEL

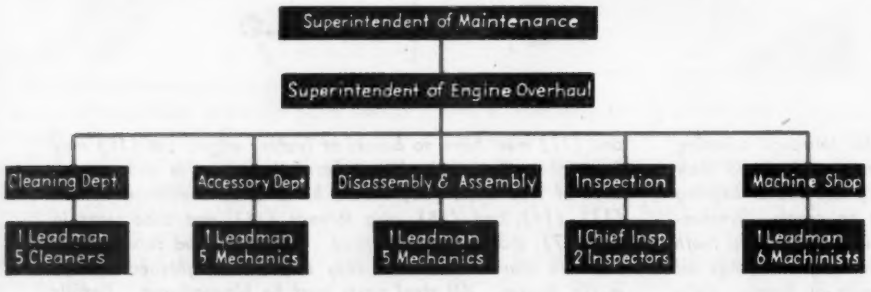


Fig. 1. Organization diagram showing distribution of engine maintenance personnel in the airline overhaul shop.

all else to the saving of a few minutes in the flow of parts through the shop.

In general, portable parts racks of the castered type, manually operated parts cleaners, and small but adequate machine shops that refer to the engine manufacturer for major reworks, have served well in the past, and will continue to do so for some time to come.

Following are two typical examples of the small, flexibly operated type of overhaul shop just discussed. Both examples happen to be medium sized air lines; later we will discuss another similar shop operating as a profitable business in the limited private owner field.

The first airline operates 17 engines of 1,200 hp. for 700 hr. between overhauls. This time accumulates in approximately two months; therefore, about 102 overhauls are required during a year's operation.

From a total of 20 shop employees, 7 are assigned exclusively to engine overhaul. Since the accessory crew and cleaning section spread their work over a great many varied projects, they are not included in the 7-man group. Other employees might work in the machine shop, on an airplane part, or a piece of line equipment, or in the propeller, instrument, or cleaning sections.

From the organizational angle, the shop superintendent heads both the engine overhaul and the flight hangar. Next is the engine overhaul foreman. The cleaning crew is provided with a leadman; the rest of the shop dispenses with this supervisory level, since each employee is an expert or a specialist in his own right. The shop foreman also functions as a chief inspector.

Those readers who are familiar with military overhaul agencies, may notice the complete absence of packing, preserving, and storage personnel in the foregoing plan. This situation stems from the commercial engine's characteristically rapid shuttle from airliner to overhaul shop, and back into the airplane again. At no time does an engine have a chance to rest long enough to require extensive corrosion protective measures, or even crating for shipment. On the extremely rare occasions when it is necessary to change an engine elsewhere than at the overhaul base, the engines are simply loaded aboard a truck and rolled to their destination without the delays necessarily encountered in military shipping.

The second example is another airline maintenance shop which is outstanding for the quality of its work and the ingenuity of its personnel. This organization works 16 Wright Cyclone G202 engines 800 hr. between overhauls. Any given engine accumulates its time in about 2 months to 10 weeks.

CONTINUOUS-FLOW OVERHAUL DEPOT ORGANIZATION

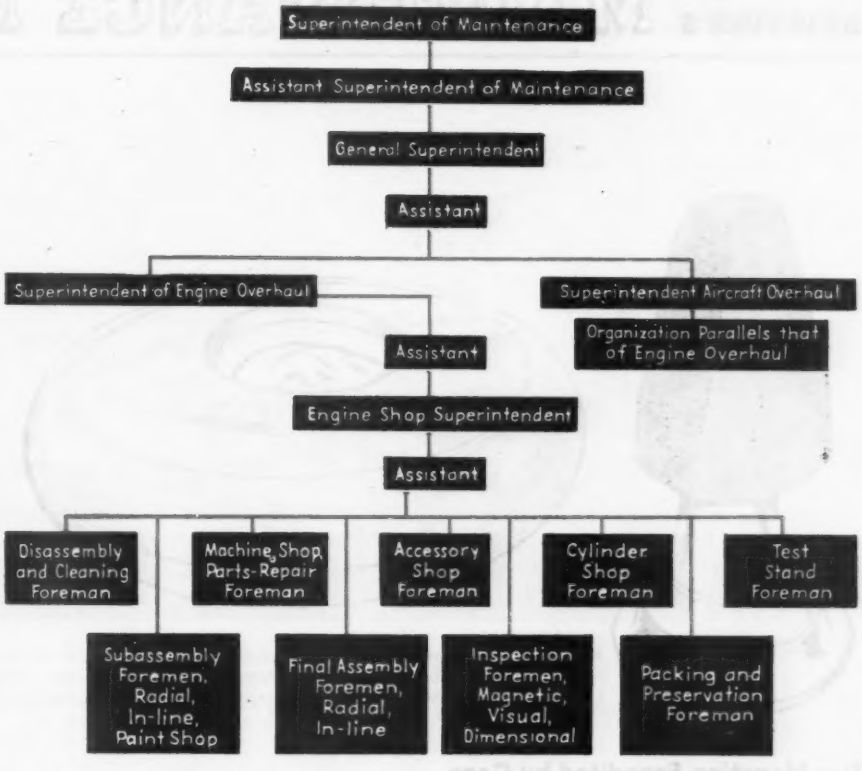


Fig. 2. Contrast this continuous-flow overhaul depot organization chart with that of the airline shop in Fig. 1, noting complete difference in personnel setup.

Here the personnel organization is somewhat different; each section has a leadman or his equivalent, as shown in Fig. 1.

All members of this engine overhaul group are noteworthy for their devotion to the principle of building the engine perfectly, regardless of the effort or pains required. These men move from job to job constantly, and as a result they gain not only a wide experience but also an enlightened perspective of each engine part's importance in its relation to the entire assembly. Also, this practice eliminates bottlenecks arising from one specialized worker's absence due to illness or vacations.

These mechanics own and take pride in their private tool kits. During slow periods they are encouraged to spend their time developing and building new equipment, tools, gadgets, and experimenting with ideas for improved operation.

This organization is the modern outgrowth of the old-time closely-knit craftsmen's guild. It is admirably suited to the airline its serves, and it stands, moreover, as a shining example for those who would plan a general overhaul service for private airplanes. The keystone of such a shop is personnel selection, also credited are friendly, personal, supervisory contacts dealing with each man as a respected craftsman.

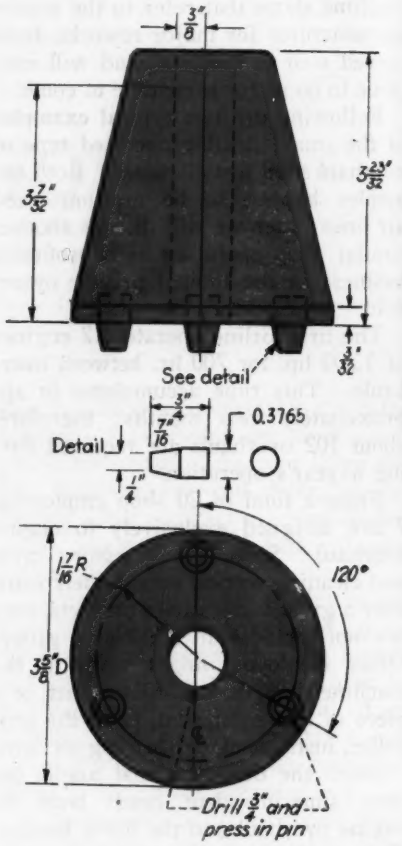
At the opposite pole, as far as organization is concerned, is the continuous-flow overhaul shop (Fig. 2). Before examining a sample of this kind of shop, let us consider the various factors that automatically eliminate the versatile mechanics that contribute so much to the small shop. First, it would probably be physically impossible to locate the great number of skilled mechanics required. A large overhaul depot, for example, employs about 1,200 people. Second, the constant shifting of personnel from section to section and job to job would soon spell hopeless confusion and practically eliminate any chance of careful supervision.

Many other factors enter this picture. For instance, if the shop works several shifts, one worker must be able to pick up where the other left off without finding that the first man was going about the job in a distinctly individual manner.

There must be no doubt as to whether the men use the proper tools. Rather than take chances on makeshift devices and dangerous practices, the employee-owned tool system is ruled out in favor of carefully chosen tools, in good condition, available from the tool crib. If conveyor systems and mass production lines are established, it is essential that all stations be manned by workers who know the specific

(*Turn to page* 249)

AVIATION'S MAINTENANCE NOTEBOOK

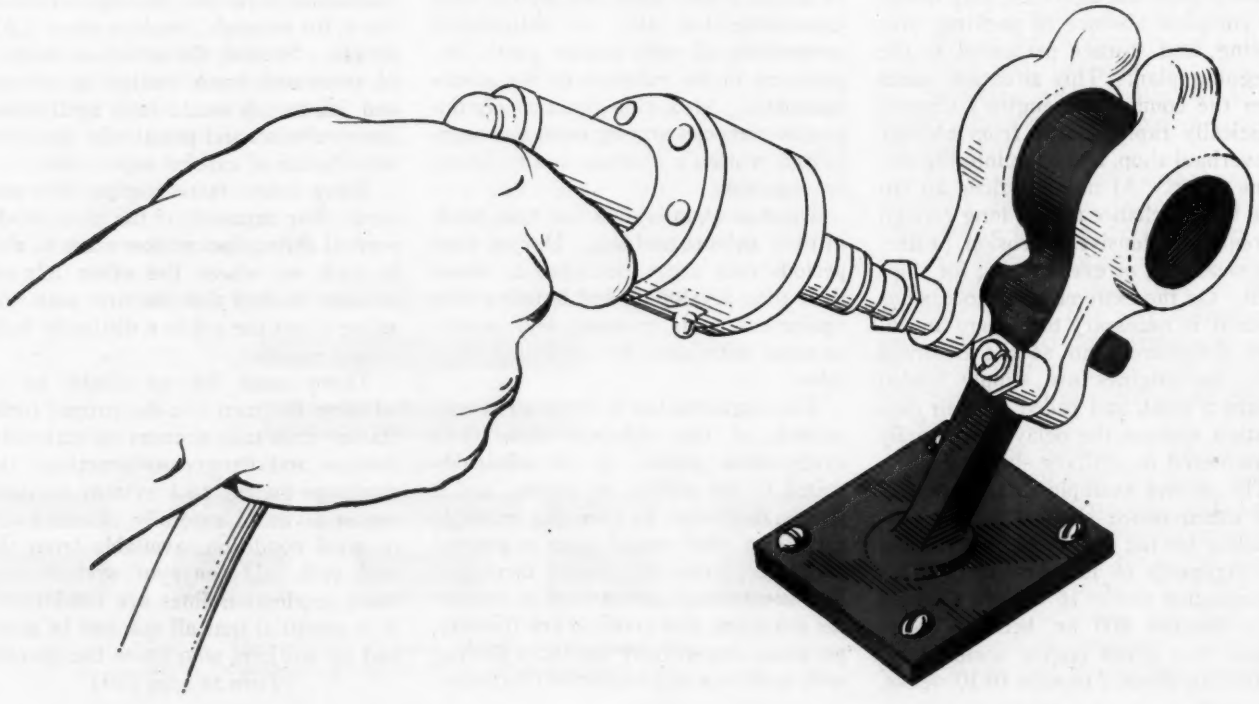


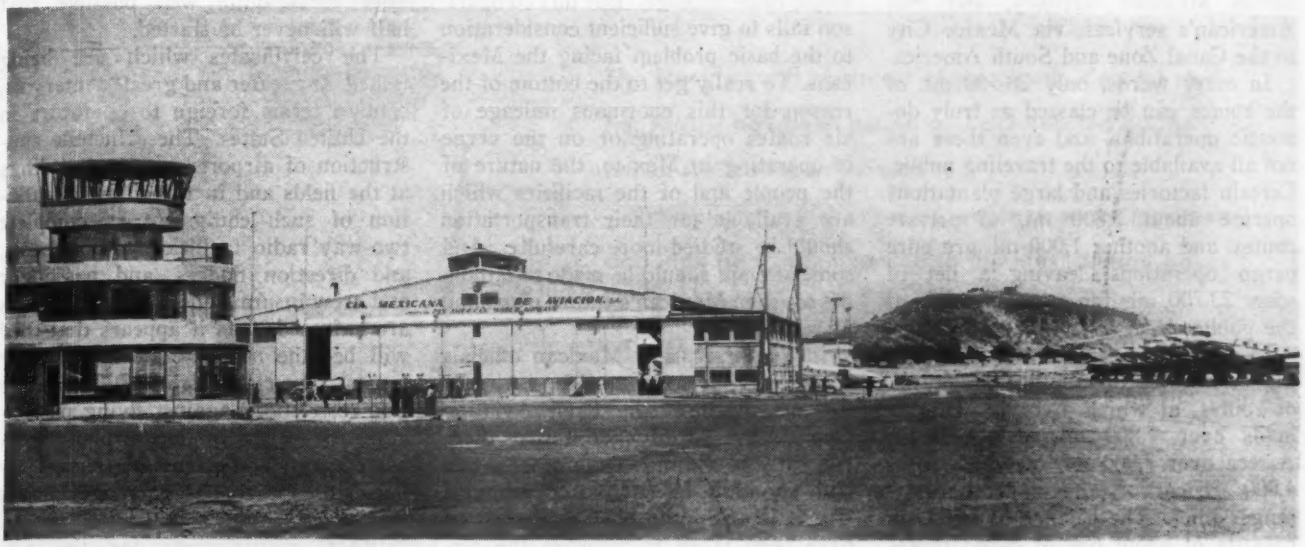
Tire Mounting Expedited by Cone

• For mounting tires with small hub opening, cone illustrated saves 75% of time formerly required. Suggested by John A. Parker, Marianna AAF, cone is used on end of hub to facilitate sliding of tire and tube into position.

Rocker Arm Stand Protects Hands

• For installing valve adjusting screw assembly on rocker arms, E. O. Steitle, of San Antonio ATSC, built this special support, onto which rocker slides, being held in position by cross arm. Rocker may be reversed if it is desired to clean threads by running tap from back.





Mexico City's airport as it is today. Its expansive layout is keyed to accommodate the increasing traffic now promised as transport operators draft broad plans for postwar networks meeting long-unfulfilled needs of Republic. (Wide World photo)

HOW MEXICO IS GIRDING FOR TOMORROW'S AIR TRANSPORT

By A. A. HARTSINCK

With much of its ground travel curbed, or at best circuitous, due to barriers of terrain, Mexico looks to the air for a solution of its transportation difficulties—and the solution bids fair to expand the country's economy to a status more nearly commensurate with its vast potentials. Here is a detailed analysis of the Republic's air transport picture, written by an aviation consultant after a first-hand survey.

DURING THE PAST YEAR, much attention has been focussed on the development of civil aviation in our neighboring Mexico. This country has long been an operating sphere for Pan American Airways and its subsidary, Compania Mexicana de Aviacion (CMA), these services being carried on successfully for many years, with only competition of sorts from the smaller operators.

However, during 1943 and 1944, other airlines developed pointed interest in airline operations in the Mexican Republic; notably, American operators started new companies or bought control of existing airlines. One of these enterprises is Lineas Aereas Mexicanas, SA, better known as LAMSA, owned by United Airlines. Another is Aerovias Braniff, SA, a new company set up by Tom Braniff.

Other companies are controlled by American capital; for instance, Aeronaves de Mexico, SA, is a partial subsidary of the Pan American Airways System, while Aero-Transportes, SA, is controlled for 66⅔% by two Richmond, Va., businessmen, Messrs. Markel and Brinson. Furthermore, during the past few months, another airline has appeared on the scene, Aerovias Azteca, SA, which is primarily financed by a group of Los Angeles businessmen without prior aviation experience.

This new carrier, little publicized as yet, obtained what are believed to be the first commercial air cargo certificates in Mexico, besides extensive concessions for passenger routes, which in many respects virtually duplicate CMA's routes and which total some 7,900 mi. covering most of the Republic. The line is reported to have started initial operations with two Budd RB-1 Conestoga's on Apr. 1.

To properly assay the air transport position in which Mexico now finds itself, mere statistics and reviews of the development of the various airlines are unsatisfactory. No comparison of the extent of the Mexican airline network with that of the United States should be made without further consideration of the country itself and of its broad status regards transportation facilities.

While it is quite true that at the end of 1944 there were some 35,500 mi. of airlines in operation in Mexico, over 7,000 mi. were classed as "international." These latter operations included American Airlines' run to

Mexico City from the United States, Transportes Aereos Centro Americanos' Mexico City-San Salvador operation, Braniff Airways' shortcuts across Mexican territory, and Pan American's services, via Mexico City to the Canal Zone and South America.

In other words, only 28,500 mi. of the routes can be classed as truly domestic operations, and even these are not all available to the traveling public. Certain factories and large plantations operate about 3,800 mi. of private routes, and another 1,000 mi. are pure cargo operations, leaving a net of some 23,700 mi. for transportation of the public clientele.

In addition, there are also outstanding certificates for another 17,200 mi. of routes, of which Aerovias Braniff holds over 7,800 mi. and Aerovias Azteca over 7,900 mi. of which some 4,800 are cargo routes and 3,100 passenger lines. The balance of 1,500 mi. consists of about 650 of cargo routes and 850 mi. of passenger routes.

Thus, Mexico with its population of some 20,000,000 and 765,000 sq. mi. of land, boasts no less than 52,700 mi. of certificated air routes, of which 23,700 are operating passenger-carrying aircraft for the public's use, with another 3,800 mi. for private use. This compares with the 48,000 mi. of routes operated by the domestic airlines in the United States which are serving 130,000,000 people and cover an area of more than 3,000,000 sq. mi.

To the observer who digs no deeper, this appears to show that Mexico has ample route mileage. But this comparison fails to give sufficient consideration to the basic problem facing the Mexicans. To really get to the bottom of the reason for this enormous mileage of air routes operating or on the verge of operating in Mexico, the nature of the people and of the facilities which are available for their transportation should be studied more carefully. And some attempt should be made to fathom the average Mexican's future plans and viewpoints.

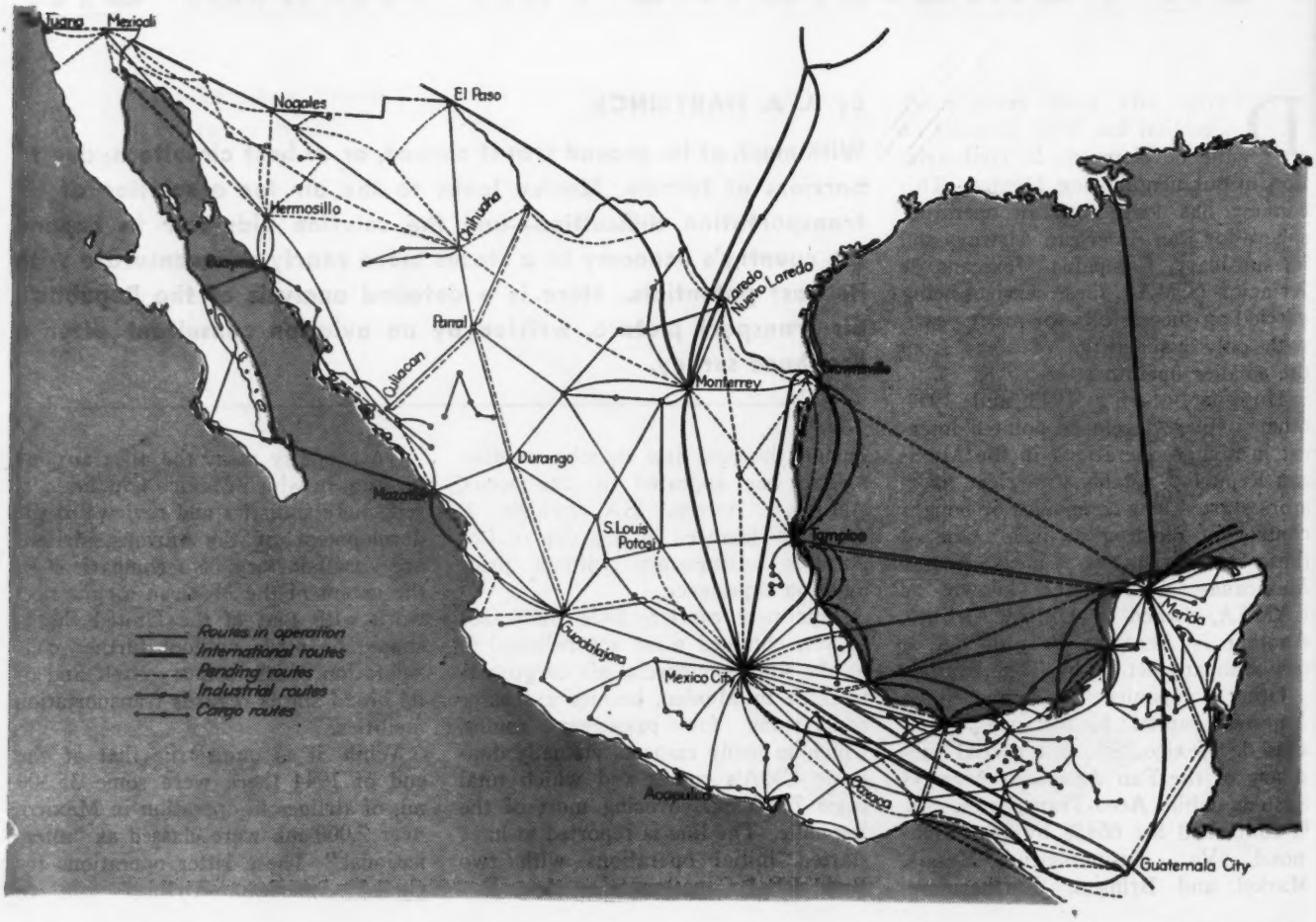
In the first place, Mexican officials such as far-seeing Gen. Alfredo Lezama, head of the Civil Aviation Department, readily admit that there currently is a minor state of chaos in civil aviation in our sister republic. But it is also quite obvious that steps have been taken to improve the airline picture. There was a time when issuance of certificates for operation of air routes was largely dependent on the political pull of the petitioner and not on his ability to actually operate the routes if he should get the certificates. Sometimes exemptions from regulatory terms of the concession were obtained, thus affecting proper operation.

The total certificates which have been issued during the past ten years are estimated at more than 100,000 mi. but the mortality rate is astoundingly high, and of the 17,000 odd mi. which were not in operation at the end of 1944 it is quite well possible that half will never be started.

The certificates which are being issued, at greater and greater intervals, contain terms foreign to operators in the United States. These include construction of airports, station buildings at the fields and in the cities, installation of such equipment as complete two-way radio facilities, radio beams, and direction finders, and passenger and crew insurance, etc., If such terms are enforced—and it appears that they will be—the new operators will *have* to run first-class airlines. There are also restrictions against flying passengers and cargo in one airplane, separate cargo and passenger planes being called for, though passenger planes may carry mail and some express. Further, requirements for the airworthiness of aircraft are being tightened.

There is pressure on many of the small "bush" operators to either sell out to larger companies with the financial backing to properly equip them with modern twin-engined equipment, or to undertake the modernization themselves.

Advent of Aeronautical Radio de Mexico, SA, a subsidiary of the Amer-



Special Delivery *to the Fleet*

NAVAL AIR TRANSPORT SERVICE

The Navy's swift conquest of the South, Central and Far Pacific has been paced and accelerated by the Naval Air Transport Service.

Critically needed supplies, replacements, personnel and mail have been carried to the most distant bases of operation in less than 72 hours by PB2Y Coronado, PBM *Mariner* and the PB2M *Mars* flying boats.

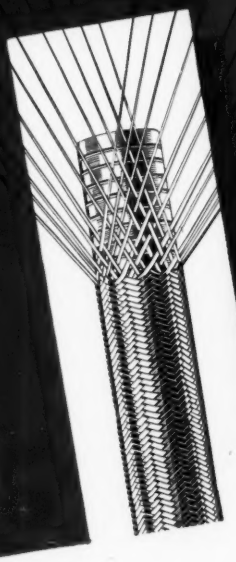
The stiff schedules operated by the NATS on the world's longest overwater routes have demonstrated the dependability of such exclusive Curtiss features as Automatic Synchronization, Reverse Thrust and erosion resistant Hollow Steel Blades.

CURTISS *Electric Propellers*

DIVISION OF
CURTISS WRIGHT
FIRST IN FLIGHT

A coil of rectangular flexible tubing.

Breeze Flexible Tubing, Shielding, Conduit Fittings



Braided wire covering forms electrical shield over flexible conduit.

Representative of standardized Breeze shielding fittings.

BREEZE MARK

● Breeze Flexible Metal Tubing solves many a design and modification problem by providing easily installed ducts and vents for air conditioning, exhaust or dust collection. Produced in a variety of metals from a continuous strip, Breeze Tubing resists heat and corrosion and is available in a variety of shapes to fit structural considerations.

Breeze Flexible Shielding Conduit is made from similarly constructed tubing with the addition of a braided wire covering which acts as a shield preventing radiation or absorption of electrical interference. Double layers of braid are sometimes specified to provide complete isolation from ultra-high-frequency interference. A variety of specially designed fittings meet every installation need.

If you are confronted with difficult tubing or shielding problems, call in a Breeze engineer for a complete analysis and recommendation.

BREEZE

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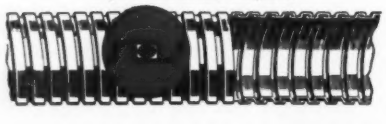
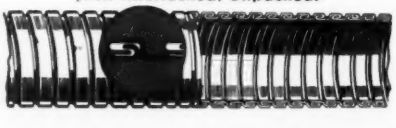
NEWARK BREEZE MARK NEW JERSEY

Square Locked, Packed.



Full Interlocked, Unpacked.



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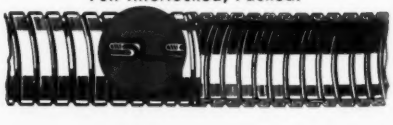


ican company, will relieve many companies of the expense of installing radio equipment on the ground, since they can contract with ARMSA for complete service. But they will still be forced to obtain new equipment and modern shops.

It is not the province of this article to go into a detailed study of the financial position of the airlines in Mexico, but suffice it to say that the larger operators, with modern equipment like Boeings, Douglas C-39's and DC-3's, and Lockheeds, are definitely making money, and that the smaller operators, while making a little money, or just breaking even, have neither the experience, personnel, or capital to undertake modernization.

In many cases therefore, the smaller lines are selling out at sometimes quite fantastic profits to the large companies; very few of them are felt to be in a position to comply with the ever more stringent requirements of the Mexican Government.

With Government pressure, therefore, there is a definite tendency of the Mexican airlines complement to resolve itself into a smaller number of financially solvent operators with modern equipment and facilities. This drive is being spearheaded by Pan American, through CMA and Aeronaves, and by Braniff, LAMSA, Aero-Transportes, and Azteca.

The situation is similar in many respects, to that existing in the U. S. in 1930, and the Mexicans are frank to warm those who they feel are *simpatico* that they know they are years behind, but just watch them catch up in the next few years!

In the second place, surface transportation in Mexico is abominably bad. The country has some 14,000 mi. of railroads (6% of the U. S. Class 1 rail mileage), and much of this mileage is narrow gage, virtually all single track. Moreover, there are only 8,000 mi. of highways which are passable at all times (against more than 3,000,000 mi. in this country) and that word "passable" in many cases should be taken with a grain of salt. Often the roads only run to places of interest to tourists rather than to businessmen, sometimes ending miles from nowhere (while awaiting completion "*manana*"). Many of the roads cross mountain terrain at 10,000 ft. or more, with hairpin curves and sheer unguarded drops of thousands of feet, hardly suitable for heavy trucking even where the road surfaces might be considered good.

Status of railroad service in Mexico is exemplified by the rail connections between Mexico City and Guadalajara, the two most important cities in the Republic. Mexico City, of course, is the national capital, while Guadalajara is the second largest city, capital of the important state of Jalisco and trade center for the entire Western section of the Republic. Notwithstanding this, there are only two trains per day in each direction—the express-sleeper leaving at night and taking about 13 hr. for the 388 mi. (if it arrives on time), and the local departing very early in the morning and bringing the traveler to his destination in a little over 18 hr., making stops at an average of less than 5 mi. intervals all along the way.

In considering these connections, it should not be forgotten that this is the fastest roadbed in Mexico, and that the train service is considered the best offered by the National Railways.

In addition, there are a number of first, second, and third class bus services, plus one direct air connection via CMA. Since this airline section is part of CMA's international route from Mexico City to Los Angeles, it is booked up months in advance; immediate transportation, that is within two or three days, is available only to priority passengers or to travelers who are able to pay exorbitant "special reservation fees" for a seat.

While service fees or tips are common on all forms of transportation to obtain good space, this system has not extended too much to the airlines, except where the loads are exceptionally heavy. These fees run from 25 *pesos* ($5) for a Merida-Minatitlan reservation to 500 ($100) for a prompt Mexico City-Los Angeles trip. Even so, the average Mexican traveler expects this, and only gets angry when paying a high fee for a reservation in some conveyance which is later found to be virtually empty.

In the third place, the majority of all U. S. airline operations is with large planes, the average seating capacity for our entire domestic industry being 16½ seats per mile, while in Mexico it is estimated at only a little over 6 seats. Moreover, the airlines in this country operate at a frequency of ten one-way trips per day over the entire domestic network, while in Mexico the average is estimated at less than two trips per day. Many of the Mexican airlines operate from one to three times per week, except on such highly traveled sections as Mexico City to Merida, where there are actually two schedules per day (booked months in advance) and Mexico City to Los Angeles, which is flown daily.

The seemingly enormous mileage differential between the United States and Mexico is therefore reduced, by the service denominator, to a size somewhat more in proportion with the population and area of the country.

Finally, the average Mexican, besides being acutely and rightly proud

(*Turn to page 270*)

AIRLINES IN MEXICO

(As of Oct. 31, 1944)

Code Number	Company	Kilometers Certificated
International Routes:		
1	Pan American Airways	6,113
2	American Airlines	4,028
3	Braniff Airways	238
4	Transportes Aereos Centro Americanos TACA	1,246
Domestic Routes (Passengers, Mail and Express):		
11	Cia. Mexicana de Aviacion SA (CMA)	11,455
12	Servicio Aereo Panini (Panini)	3,025
13	Lineas Aereas Mexicanas SA (LAMSA)	6,433
14	Transportes Aereos Mexicanos SA (TAMSA)	3,596
15	Comunicaciones Aereas de Veracruz SA	3,235
16	Transportes Aereos de Jalisco	407
17	Aeronaves de Mexico SA (Aeronaves)	5,262
18	Transportes Aereos de Tampico, S. de R. L.	168
19	Empresa Aerochiclera, SA	292
20	Aero-Transportes, SA	2,990
21	P. A. Leopoldo Lopes T.	466
22	Guillermo L. Taboada	115
23	Aerovias Braniff, S. A. (Braniff) (1)	12,422
24	Sociedad Mercantil y de Comisiones, S. de R. L.	374
25	Helicopteros de Mexico, SA (1)	Radial
26	Aero-Transportes de Sonora, S. A. de C. V.	1,307
Domestic Routes (Cargo only):		
101	Transportes Aereos Mexicanos, SA (TAMSA)	1,619
102	Cia. Mexicana de Navegacion, S. de R. L. de C. V.	1,174
Domestic Routes (Industrial service): (2)		
201	Antonio Gutierres Sanches	301
202	Ricardo Nevares	454
203	Cooperativa "Los Chenes"	536
204	Pedro Silveira, Juan Herrera y M. Medina	113
205	Antonio del Rio	509
206	Cia. Mexicana Constructora Azteca SA	2,752
207	Nicolas Gonzales	420
208	Guillermo L. Taboada	82
209	Oscar Francke de la Pena	820
210	Pedro y Lisandro Lara	140
	Total Km.'s	72,092

(1) Not in operation as of Oct. 31, 1944.
(2) These are air services operated by large ranches or factories in inaccessible areas.

Note: Aerovias Azteca, S.A., which started experimental operations on Apr. 1, 1945, has 4,828 mi. of cargo routes and 3,103 mi. of passenger, mail and express routes.

HIGH SPEED FUEL PUMP CUTS SERVICE TIME

By fueling airliners in less time than passengers require to board it, new power unit makes enroute refueling feasible without affecting schedules.

THERE IS LITTLE REASON for sky-traveling at 200 mph. if time is wasted on the ground at intermediate stops in refuling and servicing the plane, nor is there profit in hauling large amounts of fuel in order to eliminate lost time at intermediate stops.

The obvious remedy is to refuel the airliner in no greater time than it takes to load passengers, doing the job at stops along the route.

In order to accomplish this, it is necessary to use equipment capable of handling much greater quantities of fuel per minute than has been customary, and for this purpose the Van Vleck Mfg. Co. has designed the pumping unit described herewith. Its ready acceptance by several major airlines is proof that need for this type of machine had already been recognized.

Made either in truck form (Fig. 1) or as a trailer, the unit consists essentially of four assemblies: The throw-in and brake lever mechanism (Fig. 2), pump speed governor (Fig. 3), speed stepup transmission (Fig. 4), and the pumping units (Fig. 5), of which there are two, each with a capacity of 150 gpm.

In the truck, the pump drive is directly from the power takeoff, while the trailer unit uses an engine-driven generator directly behind the cab, supplying power for enclosed electric motors at the pumps.

Throw in lever (Fig. 1) operates a vacuum cylinder which moves the splined gear into engagement with the large bevel gear on the same shaft (Fig. 4). This gear drives the smaller gears on the pump shafts at 3¾ times the speed of the power shaft. At the same time that the gear is engaged by the sliding clutch, the lever automati-

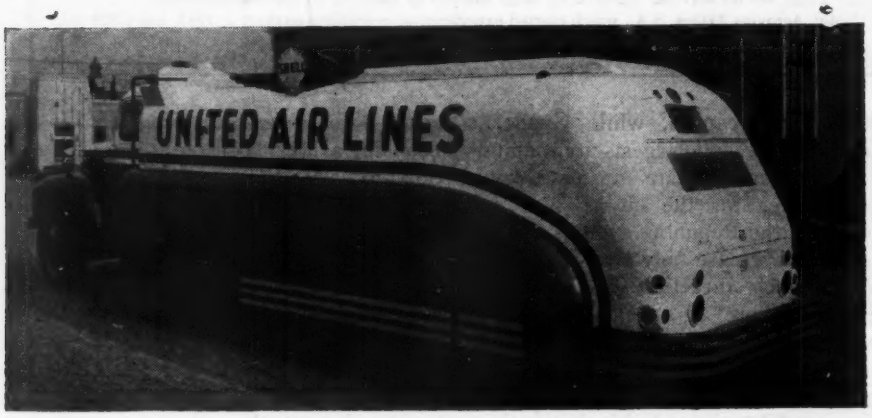
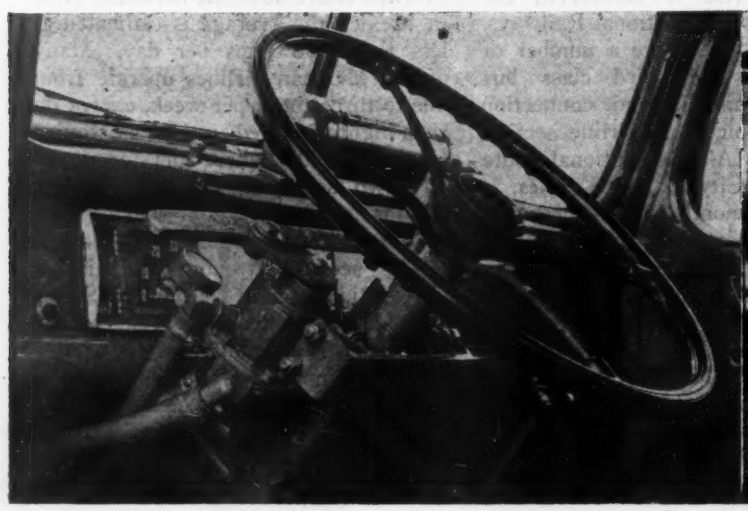
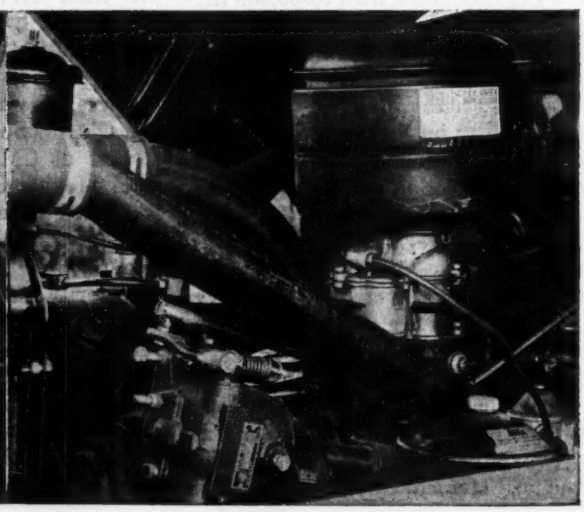


Fig. 1. With 300 gpm. pumping capacity, this truck cuts fueling time to a minimum.

Fig. 2. Lever under steering wheel applies brakes simultaneously with connecting pumps to power takeoff, rendering accidental starting impossible. Right: Fig. 3. Pump speed governor (lower left) only operates when pump is running. It holds engine at whatever speed is required to run pumps at 1,800 rpm., regardless of ratio of power takeoff thus insuring constant fuel delivery to tanks of plane.





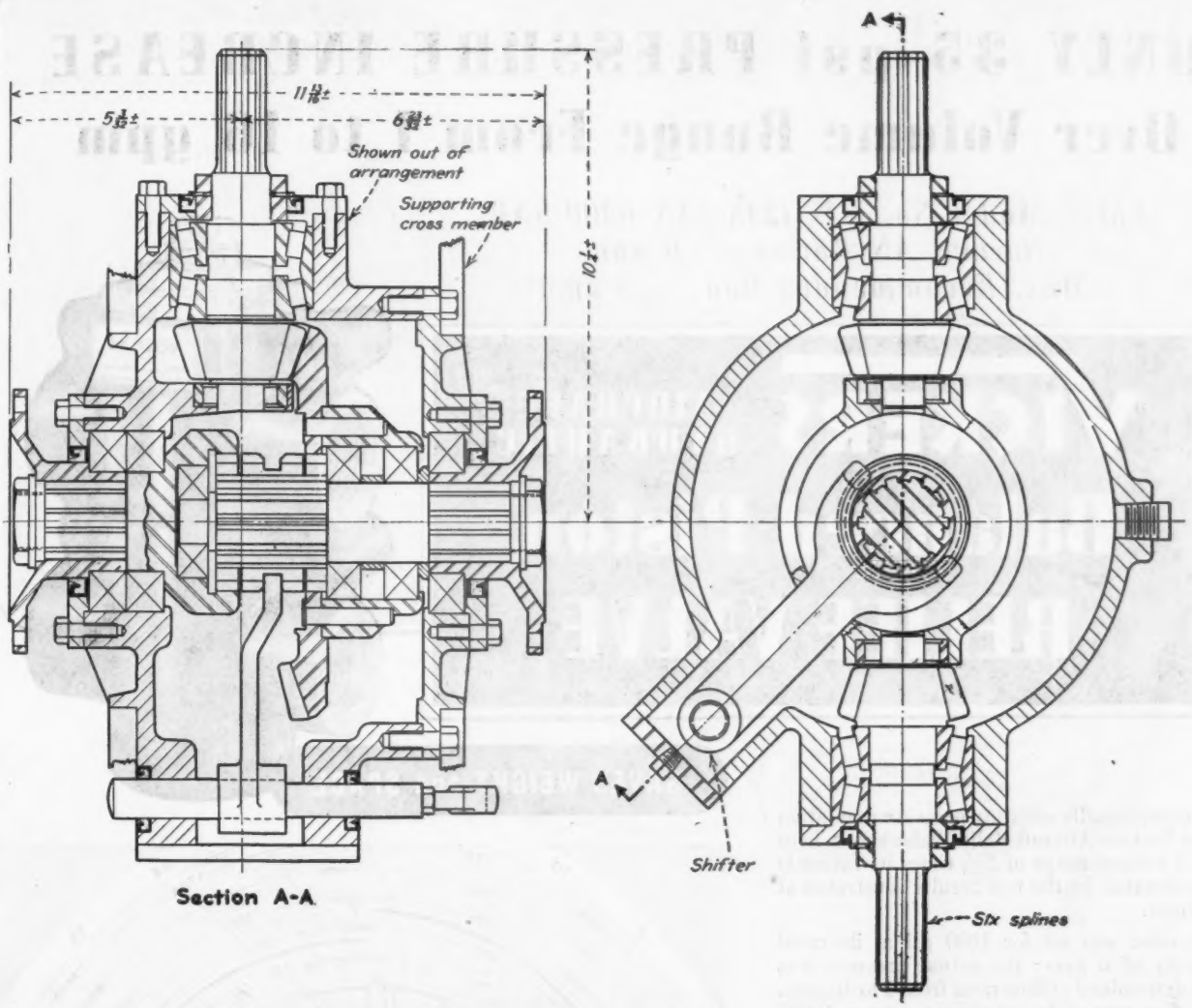


Fig. 4. Speed stepup power transmitter drives at 3¾ times drive-shaft rpm. Employed are standard moving parts, facilitating replacement at any service station. Drive is from right side, through sliding clutch.

cally applies the brakes on the truck, thus making it impossible to start the pumps until the truck has been immobilized, and also preventing the vehicle from being driven away with fuel still flowing through the pumps. A single movement of the lever controls both the pump gears and brakes.

Pump speed governor (Fig. 3) operates directly on engine throttle, but it is driven from the gear which operates the pump, keeping pump speed at 1,800 rpm., regardless of the gear ratio used at power takeoff.

Pumps are centrifugal, delivering fuel through 1½ in. hose. Since the pumps are below the tanks, no suction troubles are experienced, nor is there any variation in output from changes in pump feed. Each pump is independently driven and has a separate delivery, so that two hose lines may be used.

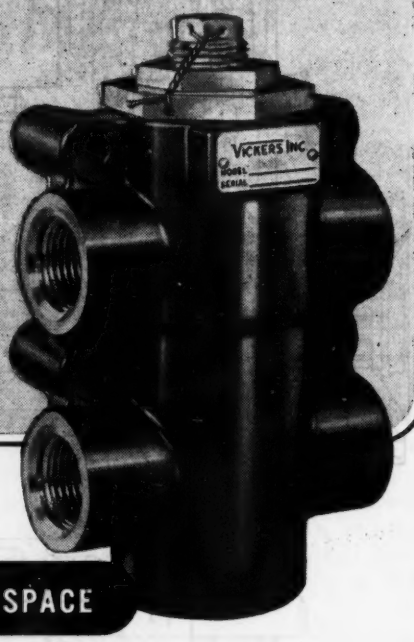
Hose rewind is power operated, saving time over the hand-winding method.

Fig. 5. One of two 150-gpm. pumps. Pump unit is at right, clutch lever above. Three parallel levers connect to various tanks. In center is meter, with hose reel at left. Driven by small airmotor and chain, reel rewinds hose as fast as it can be handled.

ONLY 35 psi PRESSURE INCREASE
Over Volume Range From 1 to 16 gpm

Valve Model No. AA-11248 (AN 6200-8AB)
Normal AN Rating . . . 6 gpm
Max. Recommended Cap . . . 9 gpm

VICKERS AIRCRAFT HYDRAULIC
Balanced Piston RELIEF VALVE



SAVES WEIGHT and SPACE

The exceptionally accurate pressure regulation of the Vickers Aircraft Relief Valve shown here over a volume range of 2⅔ times its rating is demonstrated by the test results illustrated at the right.

This valve was set for 1000 psi at its rated capacity of 6 gpm; the actual pressure was then determined at flow rates from 1 to 16 gpm. At a flow rate of 1 gpm the pressure was 995 psi and at 16 gpm the pressure was only 1030 psi . . . an increase of only 35 psi.

This ability to handle a volume much in excess of its rated capacity means that a smaller size Vickers Relief Valve can be used with a resultant saving in weight and space. These valves are available in four sizes having rated capacities of 1.2, 3.5, 6.0 (size illustrated) and 16 gpm. Without parts change, all valves have operating pressure ranges from 300 to 2100 psi; adjustment is easy. By "venting" they can be used to unload the pump in certain hydraulic circuits. These valves conform to AN specifications; they comply with AN-6200 envelope and with Winterization requirements of Army Air Forces.

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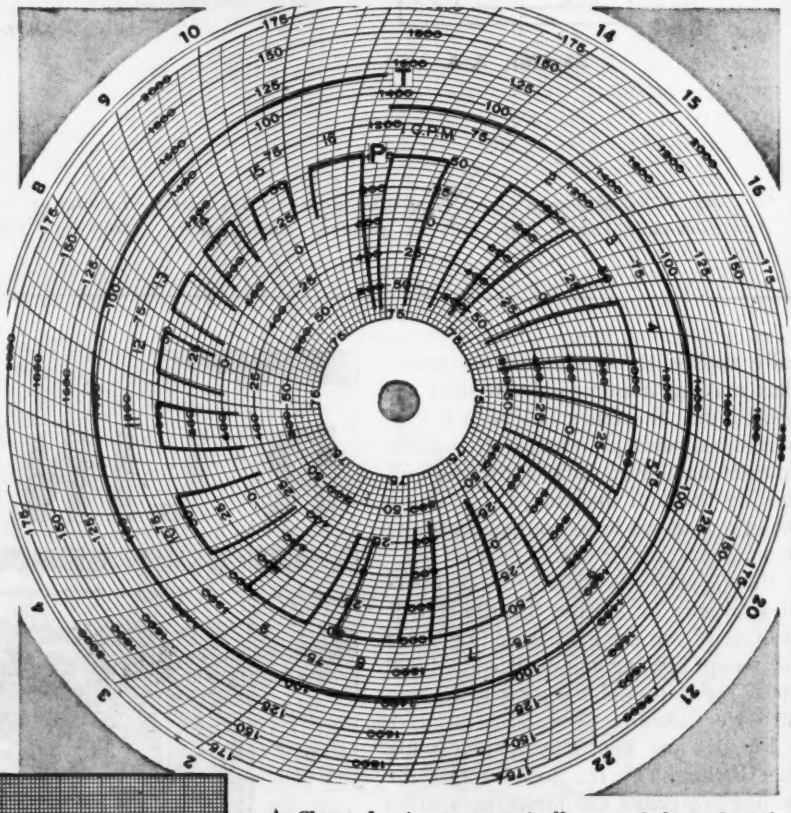
1462 OAKMAN BLVD., DETROIT 32, MICH.
ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921



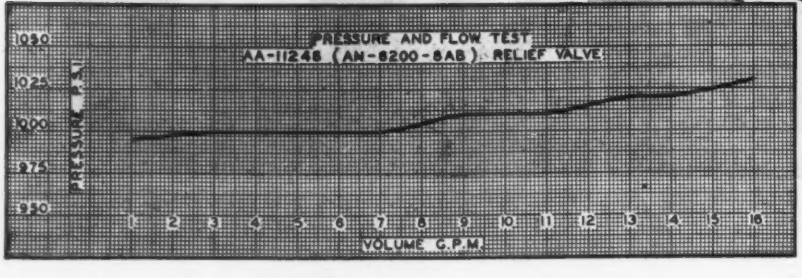
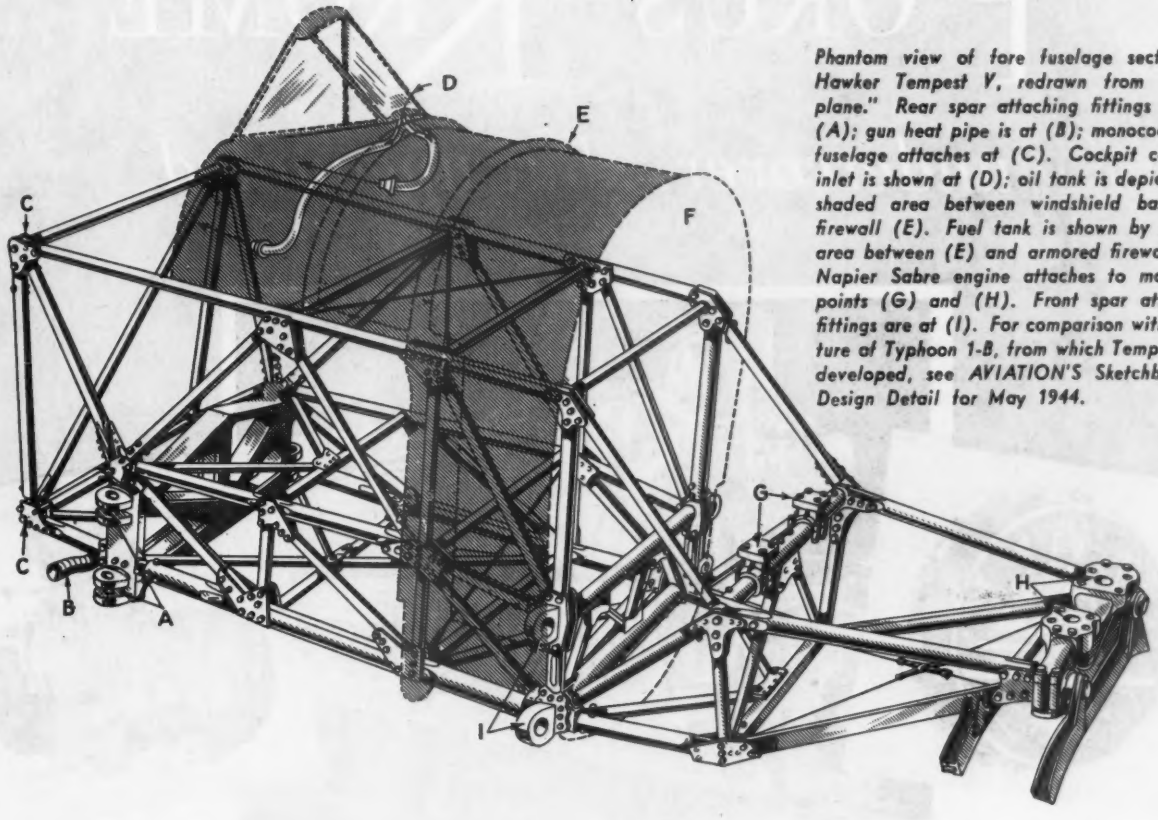


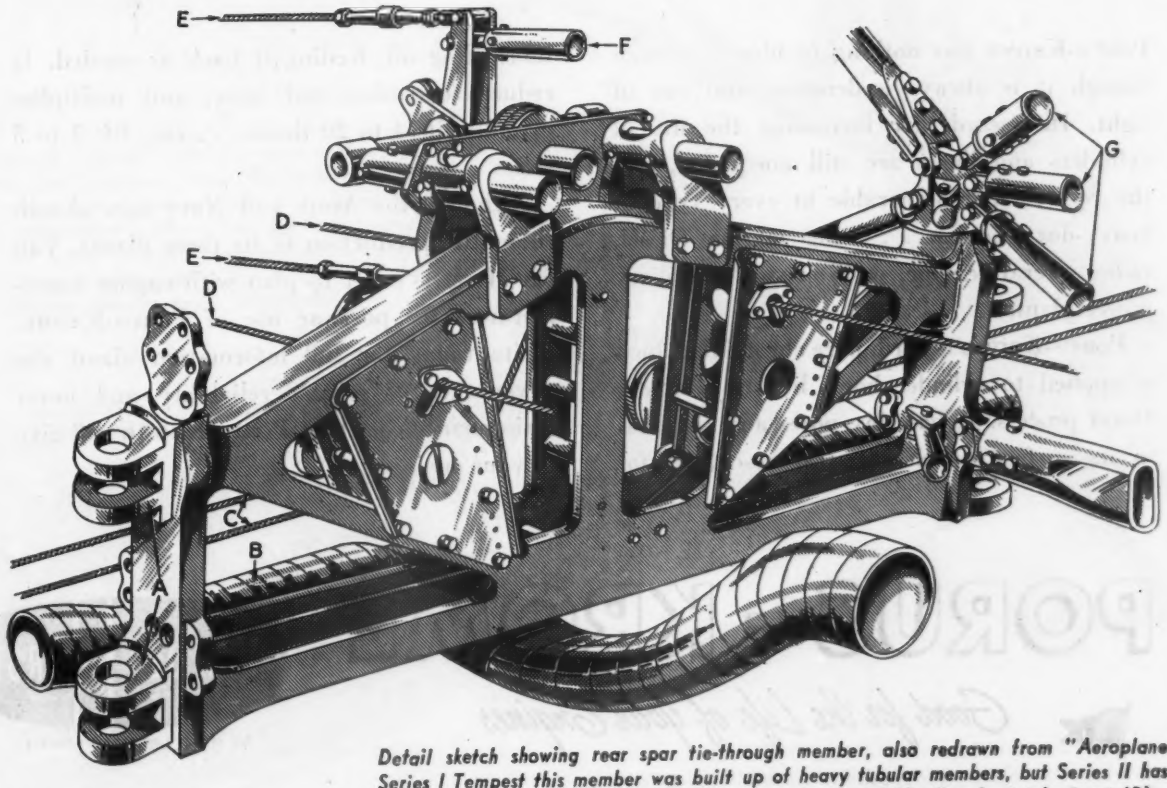
Chart showing automatically recorded results of pressure and flow test made upon Vickers Relief Valve having setting of 1000 psi at its normal rated capacity of 6 gpm. Time is in minutes. Code: "T" is temperature and "P" is pressure.

Data recorded on chart above plotted on rectangular coordinates to permit more easy evaluation. Note that pressure varies only from 995 to 1030 psi when flow rate is increased from 1 to 16 gpm.

AVIATION'S SKETCHBOOK OF DESIGN DETAIL



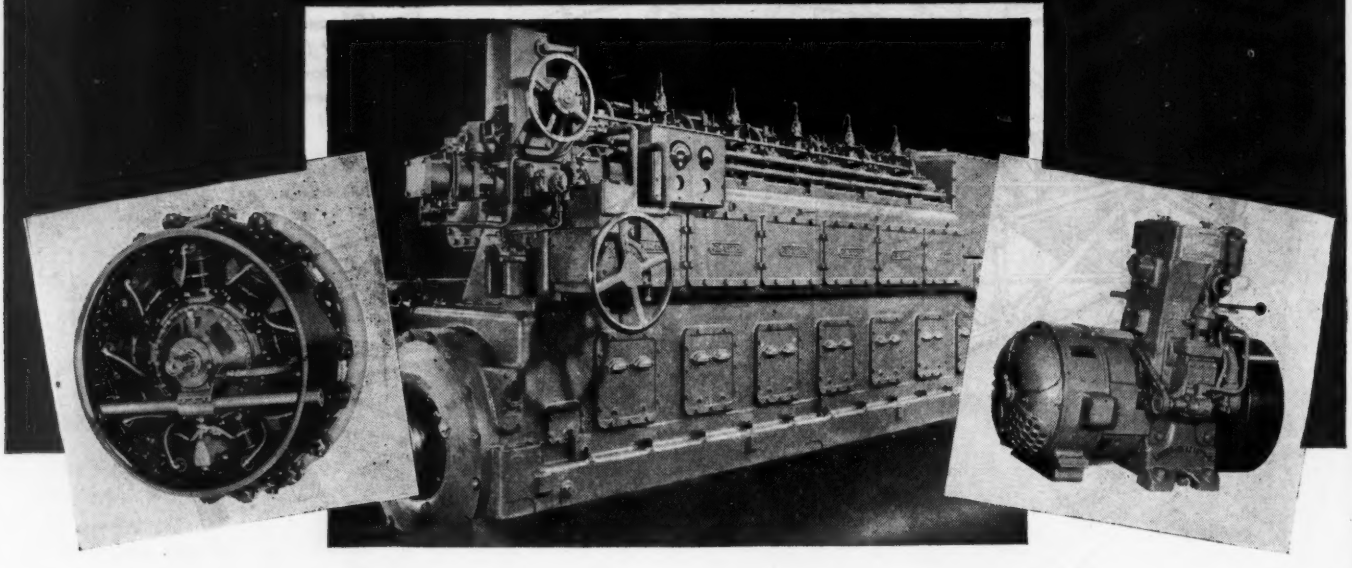
Phantom view of fore fuselage section of Hawker Tempest V, redrawn from "Aeroplane." Rear spar attaching fittings are at (A); gun heat pipe is at (B); monocoque aft fuselage attaches at (C). Cockpit cold air inlet is shown at (D); oil tank is depicted by shaded area between windshield base and firewall (E). Fuel tank is shown by shaded area between (E) and armored firewall (F). Napier Sabre engine attaches to mount at points (G) and (H). Front spar attaching fittings are at (I). For comparison with structure of Typhoon 1-B, from which Tempest was developed, see AVIATION'S Sketchbook of Design Detail for May 1944.



Detail sketch showing rear spar tie-through member, also redrawn from "Aeroplane." On Series I Tempest this member was built up of heavy tubular members, but Series II has single casting which has simplified rear spar fitting, shown at (A). Gun heat tube is at (B); aileron cables (C); rudder cables (D); elevator cables (E); torque tube to control stick (F); and fore fuselage members (G).

PORUS-KROME

undercover. . but unequaled



PORUS-KROME has nothing to hide . . . even though it is always undercover and out of sight. Its records for increasing the life of cylinders and liners are still unequaled, and the results are comparable in every type of heavy-duty engine . . . big marine Diesel, radial aircraft engine, or even small auxiliary power plants.

PORUS-KROME is hard, pure chromium which is applied to cylinder bores by the Van der Horst process. It has tiny pores and channels in its surface which serve as reservoirs for lubricating oil, feeding it back as needed. It reduces corrosion and wear, and multiplies cylinder life 4 to 20 times . . . ring life 3 to 5 times.

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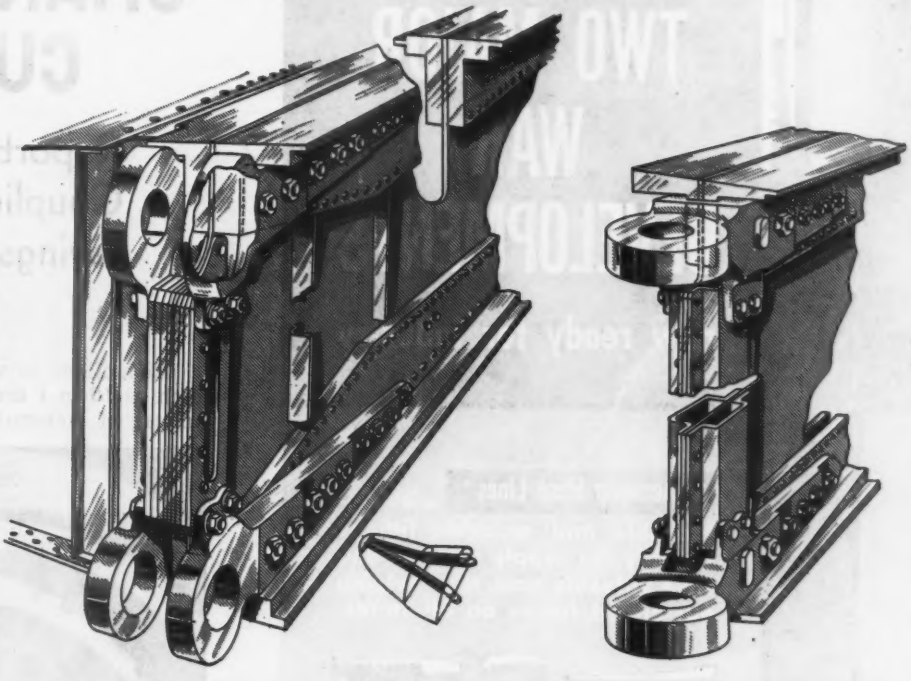
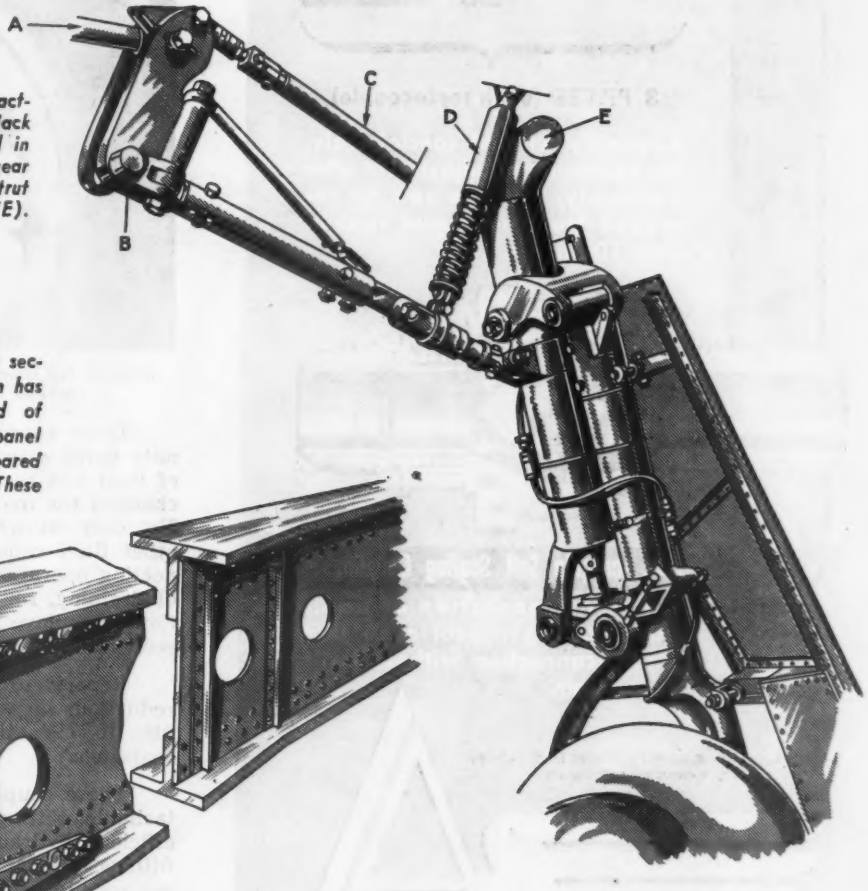
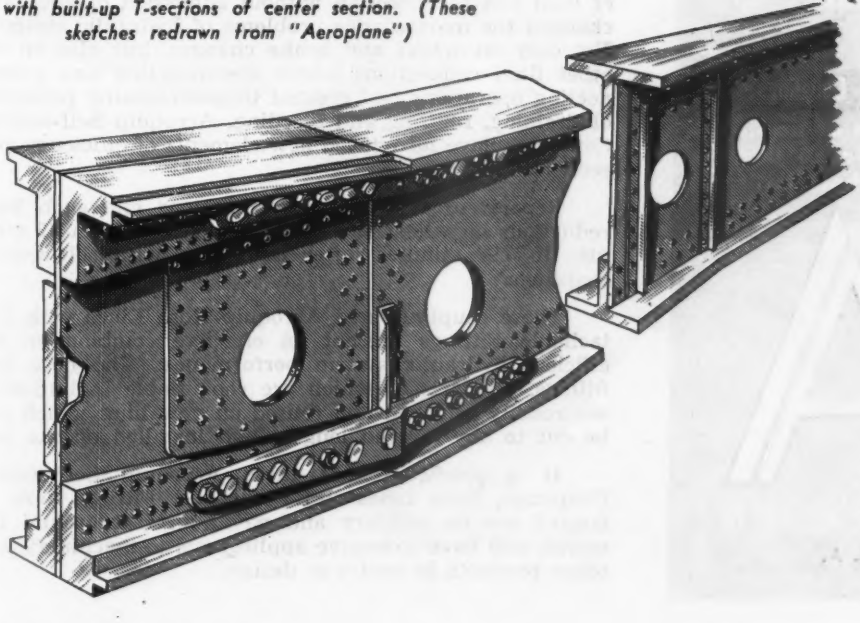


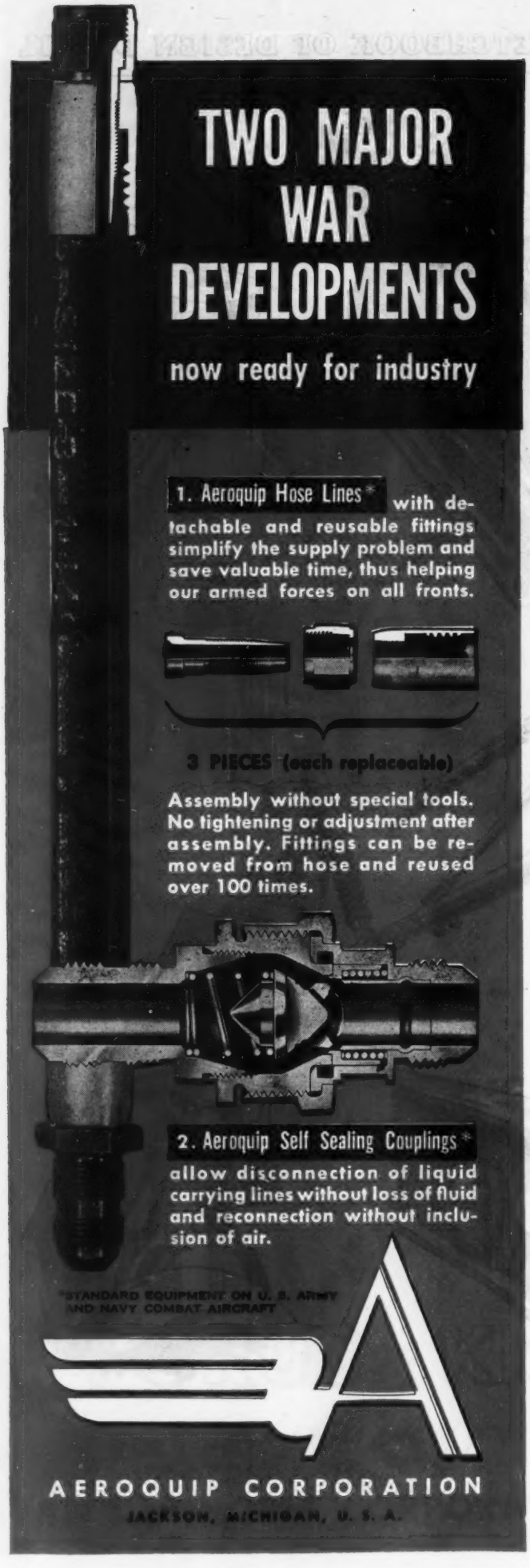
Cutaway views of root fittings of Hawker Tempest V front spar (left) and rear spar (right), with inset sketch showing relative positions in wing. Both spars have T-section booms built up of L-section extrusions riveted to heavy gage sheet web.



Detail sketch depicting Tempest V retractable landing gear, with retracting jack attached at (A), pulling unit up and in around hinge point (B). Locking gear strut is at (C); emergency assister strut is at (D). Oleo strut hinge point is at (E).

Front spar of Tempest V (below) where center section and outer panel are joined. Center section has no dihedral; outer panel—which is outboard of landing gear—has 5½ deg. Note that outer panel booms are normal extruded T-sections, as compared with built-up T-sections of center section. (These sketches redrawn from "Aeroplane")




TWO MAJOR WAR DEVELOPMENTS
now ready for industry
1. Aeroquip Hose Lines* with detachable and reusable fittings simplify the supply problem and save valuable time, thus helping our armed forces on all fronts.
3 PIECES (each replaceable)
Assembly without special tools. No tightening or adjustment after assembly. Fittings can be removed from hose and reused over 100 times.
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WHEEL and BRAKE CHANGING TIME CUT 10 to 1

Reports on Self-sealing Couplings reveal large savings . . . Bleeding time eliminated.

Reductions in wheel and brake changing time of as much as 10 to 1 are reported on aircraft installations by the use of Aeroquip Self-sealing Couplings.

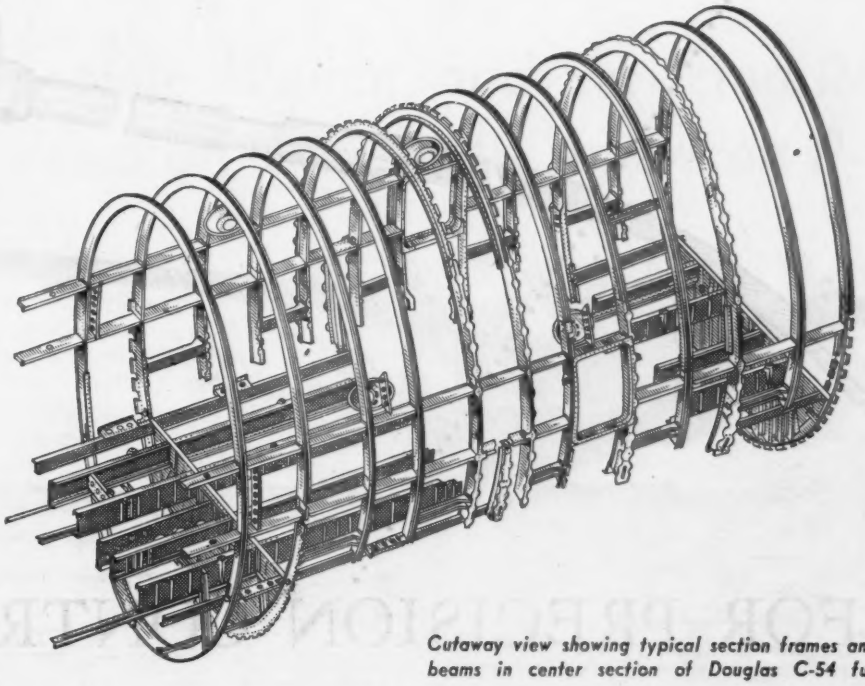
Aeroquip Self-sealing Coupling and Hose Line with Detachable Fittings installed on Hayes Wheel and Expander Tube Brakes

These couplings, whose instant sealing feature permits quick disconnection of hydraulic lines without loss of fluid and reconnection without admission of air, have changed the maintenance problems of hydraulic systems. Not only on wheel and brake changes, but also on all other fluid connections where disconnecting and reconnecting operations had created time-consuming problems of draining, refilling and bleeding, Aeroquip Self-sealing Couplings have introduced new elements of efficiency and economy.

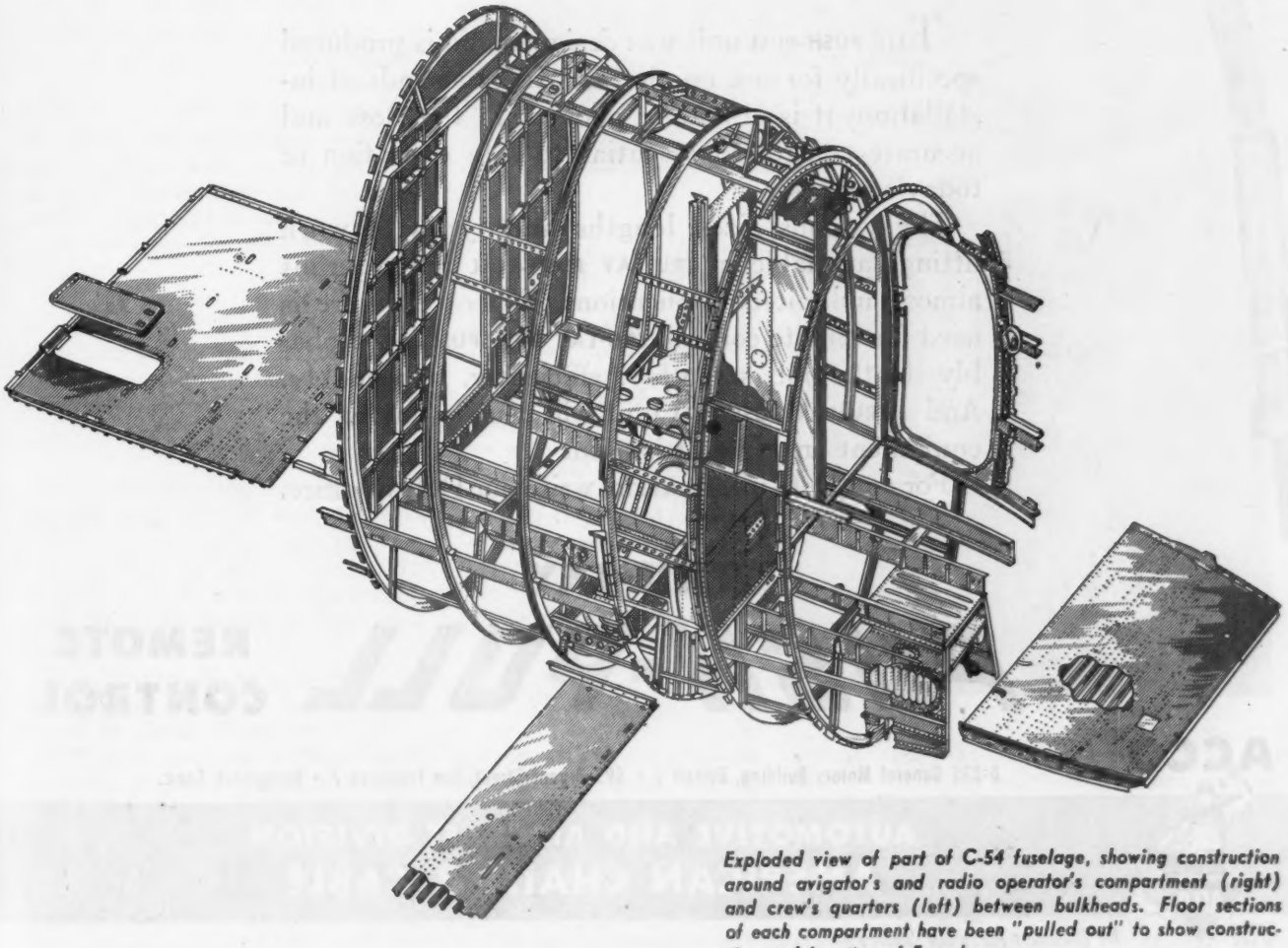
Reports of comparable installations cite such time reductions on wheel and brake changes as from 75 minutes to 7½ minutes, after equipping with self-sealing couplings.

These couplings and Aeroquip Hose Lines with Detachable Fittings present an effective combination for efficient hydraulic system performance. The hose line fittings, all parts of which are replaceable individually, are readily removed and reused on new lines which can be cut to any desired lengths and installed on the job.

It is predicted that these Aeroquip Self-sealing Couplings, Hose Lines and Detachable Fittings, now in rugged use on military and naval aircraft around the world, will have extensive applications to machinery and other products in post-war design.

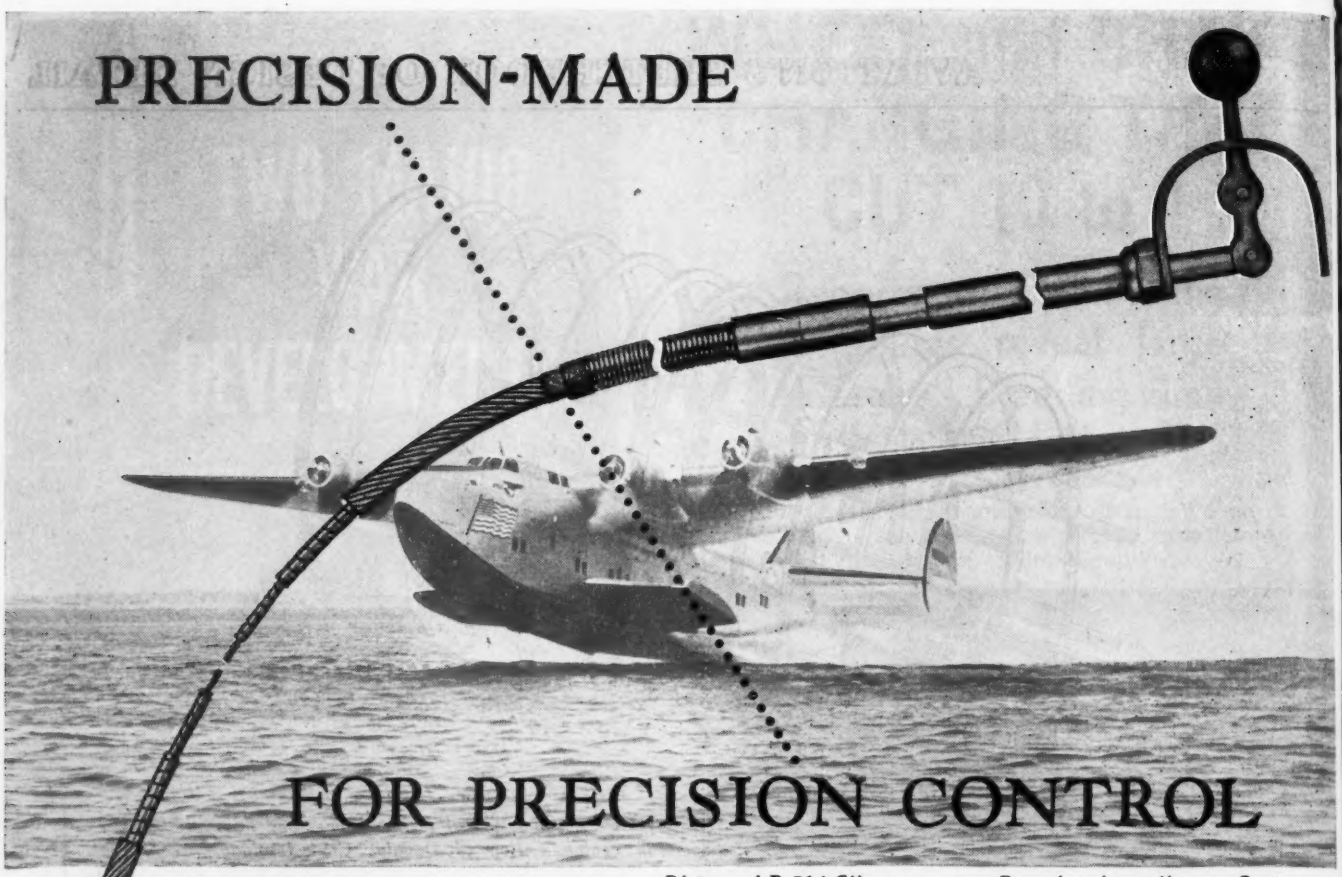


Cutaway view showing typical section frames and floor beams in center section of Douglas C-54 fuselage.



Exploded view of part of C-54 fuselage, showing construction around avigator's and radio operator's compartment (right) and crew's quarters (left) between bulkheads. Floor sections of each compartment have been "pulled out" to show construction and location of floor beams.

PRECISION-MADE



FOR PRECISION CONTROL

Picture of B-314 Clipper courtesy Pan-American Airways System

THIS **PUSH-PULL** unit was designed and is produced specifically for use on aircraft. In thousands of installations it is providing pilots with the close and accurate control so essential to safe operation of today's planes.

The various sizes, lengths and types of work fittings available in **TRU•LAY PUSH-PULL** units permit almost unlimited applications. Wherever there is need for remote control, **TRU•LAY PUSH-PULL** can probably do the job smoothly, efficiently, dependably. And a **TRU•LAY PUSH-PULL** unit will usually outlast the equipment on which it is used.

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Aerodynamic, Weight, and Servicing Refinements Featured in North American P-51

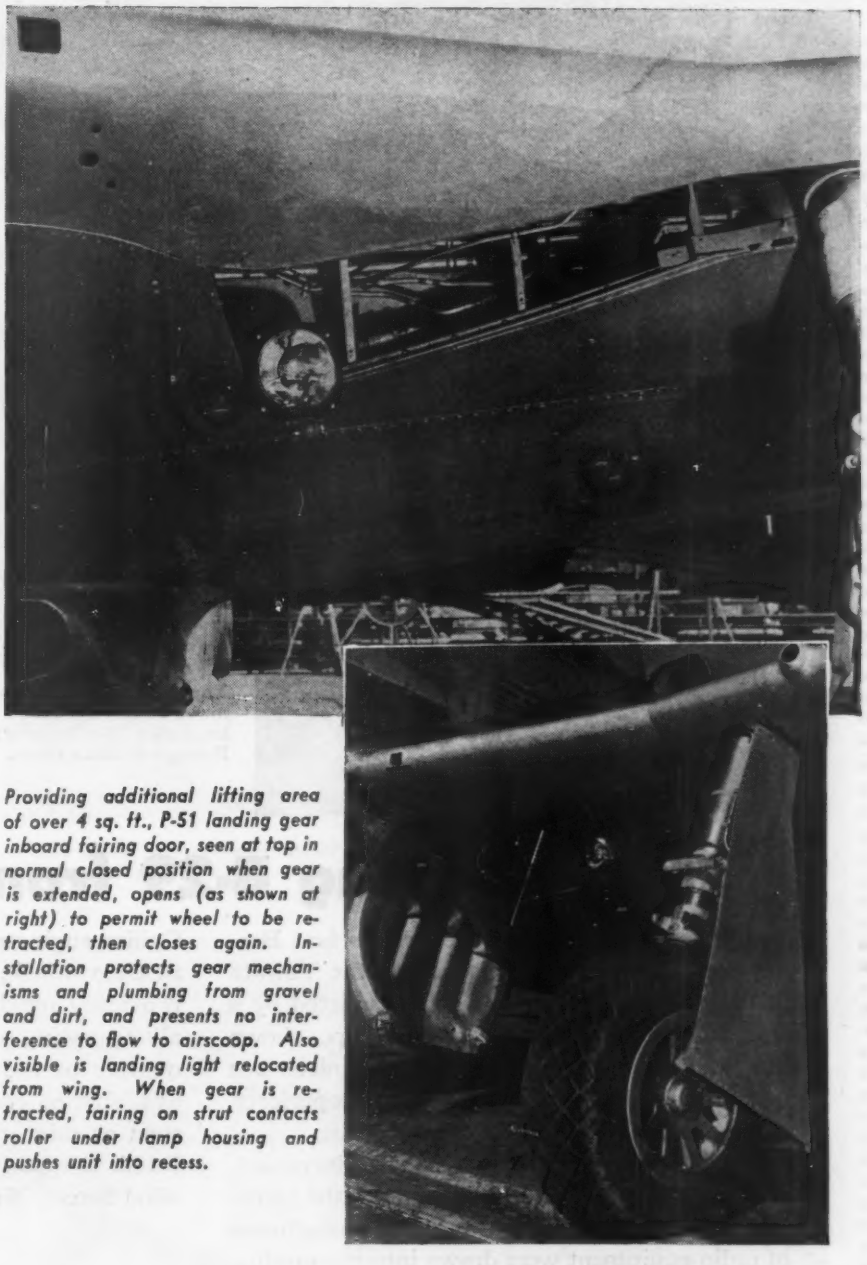
CONTINUED ADVANCES in engineering of the Mustang reflect improvements of specific interest to the aircraft designer. Among these are betterments in such installations as landing gear fairing door, landing light, gun and ammunition bay doors, shell ejection chutes, and the armored firewall.

Fairing Door

This hydraulically operated inboard unit, covering the wheel well, is hinged close to the airplane centerline, and is designed to open to permit extension of the landing gear and then close after the gear is extended. Eliminating a source of drag, the door has an area in excess of 4 sq. ft. and thus adds considerably to the lifting area of the wing —an important factor at takeoff with heavy bomb load under each wing.

Also, gravel and dirt from the propeller blast are prevented from entering the wheel well compartment and coming in contact with landing gear and door lock mechanisms, hydraulic lines, coolant pipes, and wiring circuits immediately accessible through the door opening.

And for ground operation of the plane, the closed fairing door eliminates interference with the flow to the large airscoop installation, behind and below the wheel well.



Providing additional lifting area of over 4 sq. ft., P-51 landing gear inboard fairing door, seen at top in normal closed position when gear is extended, opens (as shown at right) to permit wheel to be retracted, then closes again. Installation protects gear mechanisms and plumbing from gravel and dirt, and presents no interference to flow to airscoop. Also visible is landing light relocated from wing. When gear is retracted, fairing on strut contacts roller under lamp housing and pushes unit into recess.

Landing Light

NAA engineers found that the leading edge was not the most desirable location for the landing light, since the Mustang wing is comparatively thinner because of its laminar flow design. Curvature of the lens in the wing edge also caused refraction.

By relocating the light in the wheel well, lighting efficiency has been improved by about 40 percent.

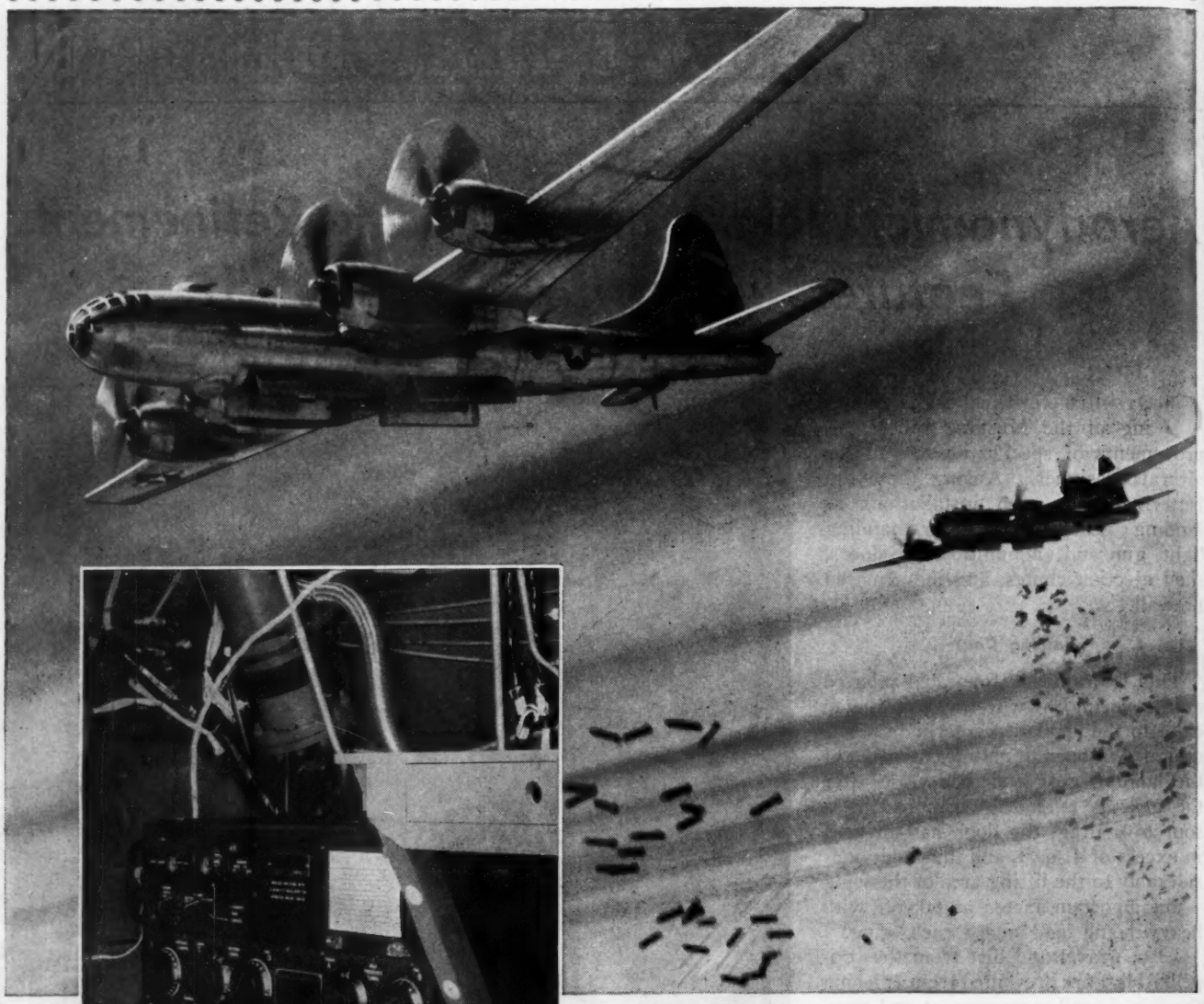
In its new location, the installation is readily accessible for quick replacement, the light beam is not obstructed, and intersection with the propeller arc is below the pilot's line of vision.

Control switch for the light is mounted on the pilot's switch panel. A spring-loaded safety switch, actuated by the support arm for the light, is connected in series with the control switch, and breaks the circuit when the landing gear strut fairing pushes the light upward into the wheel well.

Armament Access

Gun and ammunition bay doors on the P-51 embody good design for quick and easy access to armament compartments.

Access to the bays in either wing is obtained by loosening two fasteners which safety two cover latch handles, swinging the handles up, and opening the forward cover. Rear cover of the



The Collins-designed transmitter as operator sees it from his station in a Superfortress. Boeing—Wichita Photo.

Superfortresses blast and roast Japs. Official photo U.S.A.A.F.

In the Boeing B-29 from the first

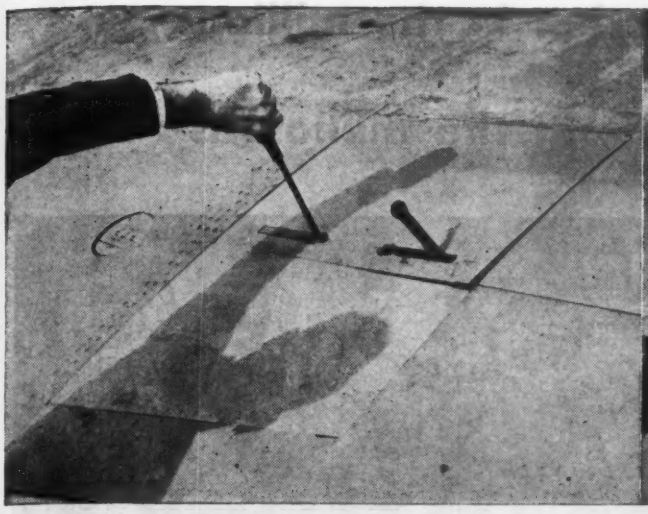
THE FIRST MESSAGE from the Army's first Boeing Superfortresses over Japan, on the Yawata mission of June 15, 1944, was transmitted by a Collins radio transmitter of the type shown above. From that time on, this transmitter has been standard equipment for all the Superforts, as it is also for the larger Naval aircraft.

As the Army and Navy demand increased, requirements exceeded the capacity of the extensive Collins facilities, and other manufacturers of radio equipment were drawn into the production program, aided by Collins engineers. Total deliveries have been very large.

Collins engineering and production have gained much valuable experience during the war in providing reliable radio communications under all operating conditions in practically every quarter of the globe. This experience will be available to commercial and personal users as soon as military requirements permit. Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

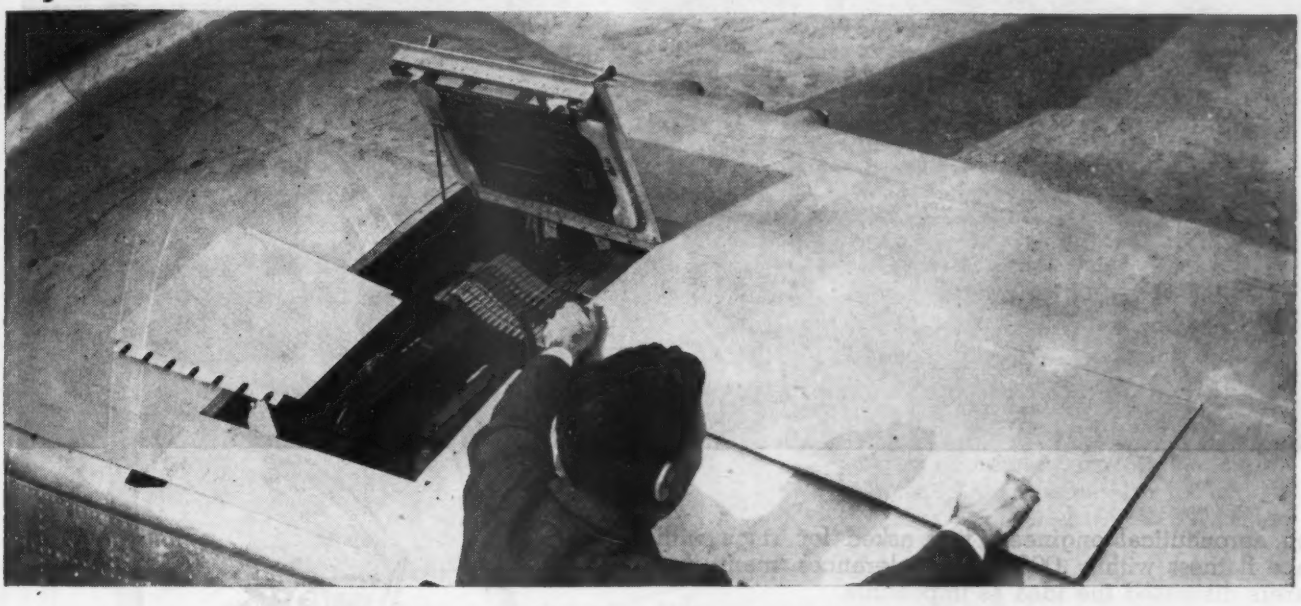
IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

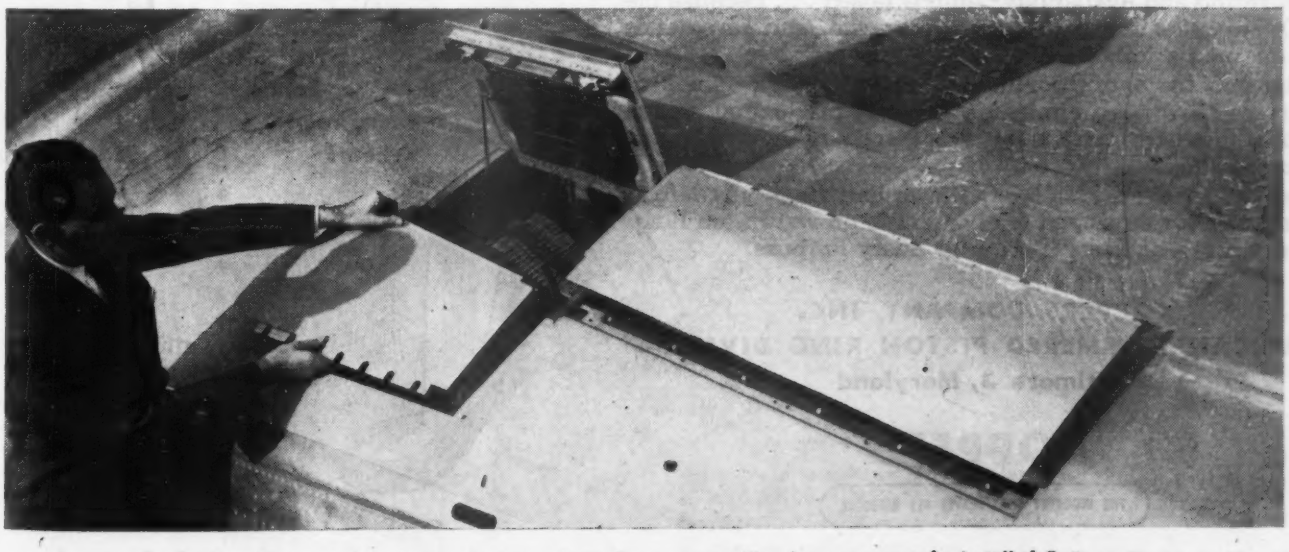


First step for quick access to gun and ammunition bays of Mustang is loosening of two fasteners in the cover latch handles. This permits raising of cover over forward part of gun bay.

With hinged cover raised, rear cover of gun bay may then be removed by pushing forward. Access to ammunition bay on right is had by raising short lever to free one side of ammunition bay cover.



With ammunition bay cover unlocked, it is pulled backward and lifted out with aid of handhold at right. Note that rear cover of gun bay has been removed at the left.



In replacement procedure, rear cover of gun bay or ammunition bay cover may be installed first.

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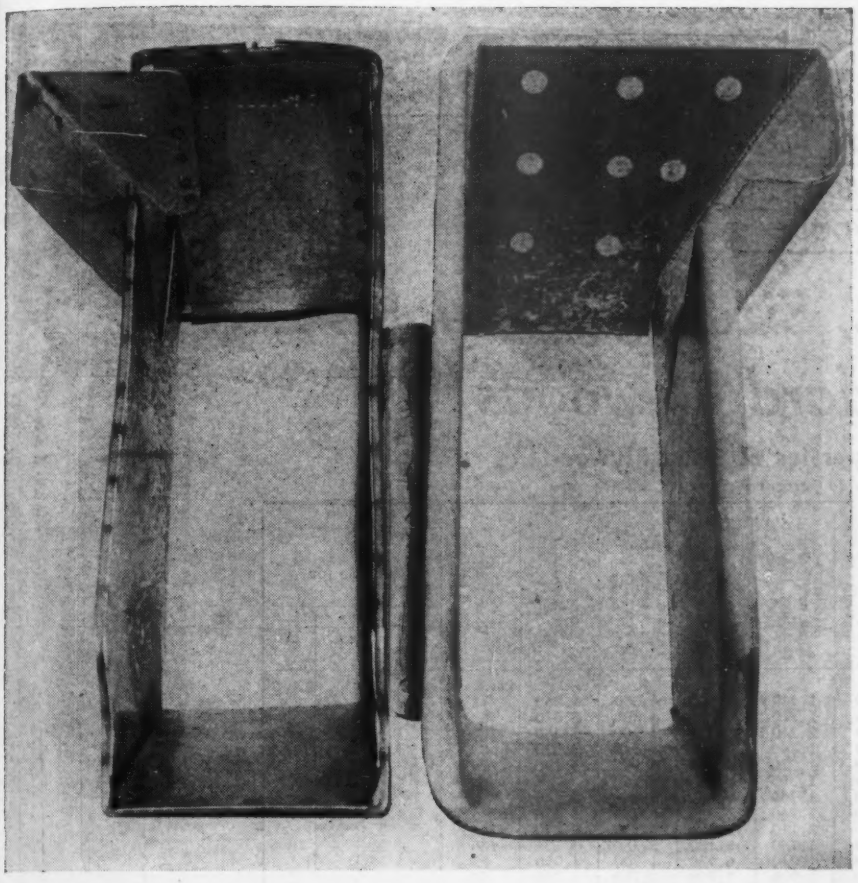
FOR TOMORROW—*Count on those who are doing the tough job today*



Here (left) is seen stainless steel shell ejection chute after some thousands of rounds had been fired. Note result of peening action of shell cases. Shown at right, at conclusion of same number of rounds, is new phenolic fiber chute with similar material for striking plate. It exhibits superior characteristics.

gun bay may then be lifted out to fully expose the three .50-cal. guns.

Access to the ammunition bay is provided by raising a handle in the gun bay to free one side of the ammunition bay cover, which then may be lifted out. This gives access to the three ammunition belts.

The two removable doors are replaced first, and the hinged gun bay door is closed last. This interlocking door arrangement greatly speeds work of armament men when servicing the guns and reloading between combat missions.

Shell-Ejection Chutes

Phenolic fiber shell-ejection chutes recently designed for the Mustang have been found superior to stainless steel for this purpose, after exhaustive firing tests.

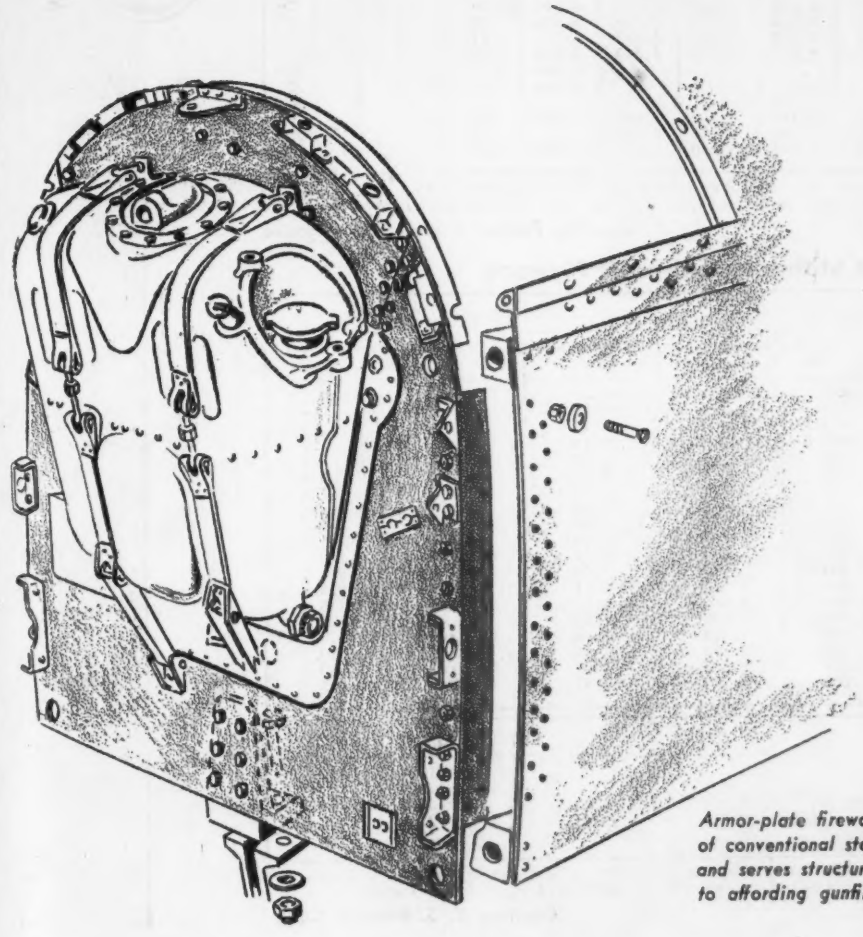
Impact of the .50-cal. brass shell cases against the ejection chute edges caused warping of the stainless steel, which would not return to its original formed shape. Also, peening action of the empty cases against rivets on the inside of the striking plate damaged them so severely that at the end of some 4,230 rounds the plate fell off.

The fiber chute acted as a cushion for the shell cases, and after firing more than 10,000 rounds, examination showed the new installation to be superior.

Also, phenolic fiber chutes are quicker to manufacture — requiring only about 25 min. compared to more than 1 hr. for the stainless steel chutes.

Firewall

Designed to save weight and material, the firewall on the P-51 is fabricated of armor plate and does double duty by serving as a structural member attaching to upper and lower longerons, and providing protection for the pilot from frontal enemy gunfire. The installation thus eliminates the need for the usual stainless steel firewall with additional backing of armor plate.



Armor-plate firewall on P-51 takes place of conventional stainless steel installation and serves structural purpose in addition to affording gunfire protection.

Characteristics, Sizes and Weights Of Standard Plywoods

Physical Properties of 3-Ply Plywood

(8 to 10 percent moisture)

SPECIES	Average Specific Gravity, oven-dry weight, air-dry volume	Column Bending Modulus, lb. per sq. in., force applied parallel to grain	Modulus of Elasticity, column bending, 1,000 lb. per sq. in.	Tensile Strength, lb. per sq. in., parallel to grain	Tensile Strength, lb. per sq. in., perpendicular to grain	Compression Fiber Stress, lb. per sq. in.	Splitting Resistance, percent of birch	Service Suitable for			
								A	B	C	D
HARDWOODS											
Ash, Commercial white	0.60	9,930	1,420	6,510	4,350	5,250	71				
Basswood	0.42	7,120	1,210	6,880	4,300	3,370	63				X
Birch, yellow	0.67	16,000	2,260	13,210	7,700	5,480	100	X	X	X	
Cottonwood	0.46	8,460	1,440	7,280	4,240	3,520	85				
Elm, American	0.52	8,680	1,220	5,860	3,990	5,180	75		X	X	
Gum, tupelo	0.50	7,760	1,300	6,260	3,760		60				X
Mahogany, African	0.52	8,070	1,260	5,370	3,770	4,280			X	X	
Mahogany, Khaya	0.48	8,500	1,940	6,390	3,780	4,880			X	X	
Maple, hard	0.68	15,600	2,110	10,190	6,530	5,620	114	X	X	X	
Maple, soft	0.57	11,540	1,750	8,180	5,380		106		X	X	
Oak, commercial white	0.64	10,490	1,340	6,730	4,200	4,950	85				
Poplar, yellow	0.50	8,860	1,920	7,390	4,720	3,750	51				X
Sweetgum	0.54	9,970	1,590	7,850	4,930		80				
Sycamore, American	0.56	11,040	1,630	8,030	5,220		77		X	X	
Walnut, black	0.59	12,660	1,740	8,250	5,260		77	X	X	X	
SOFTWOODS											
Cedar, Spanish	0.41	6,460	1,030	5,200	3,340	4,320	60				X
Cypress, bald	0.45	8,890	1,220	6,160	3,980	4,960	49				
Fir, Douglas	0.48	9,340	1,530	6,188	3,910	5,600	93				X
Hemlock, western	0.47	9,250	1,580	6,800	4,580		63				X
Pine, eastern white	0.42	10,130	1,570	5,720	3,340	3,840	31				X
long leaf						5,280					X
ponderosa						4,240					X
short leaf											X
sugar	0.42	8,050	1,310	5,430	3,690	3,680	47				X
Redwood	0.42	8,230	1,180	4,770	2,960		48				X
Spruce, Sitka	0.42	7,710	1,370	5,650	3,410	4,000	78				X

A — Hardness, abrasion resistence and fastening strength. B — Finish or appearance. C — For plywood that is to be steamed or soaked before being bent into a form or shape that is to be permanent after forming. D — For plat panels that require high bending or high column strength with minimum weight.

Courtesy Product Engineering Magazine

Sizes, Weights, and Stiffness of Aircraft Plywood

Thickness of Plywood, in.	Number of Plies	BIRCH			POPLAR OR SPRUCE		
		Estimated Weight, lb. per sq. ft.	Stiffness Factor (EI), lb. in.		Estimated Weight, lb. per sq. ft.	Stiffness Factor (EI), lb. in.	
			Long.	Trans.		Long.	Trans.
1/32	3	0.18	7.5	0.5	0.13	5.3	0.5
3/64	3	0.21	13.6	1.5	0.15	9.3	1.2
1/16	3	0.29	41	5.5	0.19	30.0	4.0
5/64	3	0.33	70	4.7	0.22	51.5	3.4
3/32	3	0.42	24	24.0	0.29	119	17.4
1/8	3	0.50	290	57.5	0.34	212	42
5/32	3	0.64	650	80	0.43	480	60
3/16	3	0.75	970	185	0.49	705	135
3/16	5	0.78	905	330	0.53	660	240
1/4	5	1.00	2,000	650	0.66	1,460	490
9/32	5	1.16	3,900	1,270	0.77	2,860	925
5/16	5	1.32	4,225	1,690	0.87	3,080	1,225
3/8	5	1.58	6,550	3,600	1.04	4,765	2,625
1/2	7	2.05	16,400	7,500	1.36	11,970	5,650
5/8	9	2.52	28,700	18,250	1.65	21,100	13,320
3/4	9	2.97	49,500	29,800	1.97	36,900	21,680
1	11	3.90	121,000	64,300	2.57	88,400	48,425

MATERIAL	STIFFNESS (EI) FACTOR[1]
Spruce (lightest commercial natural-density) plywood	416.0
Birch (heaviest commercial natural-density) plywood	178.0
Tegowood (high-density plywood) 1/45-in. birch veneers	30.0
Aluminum	22.0
Steel	3.1

[1] Obtained by multiplying the modulus of elasticity by the moment of inertia of a section 1 in. wide and of a thickness h equal to that of a sheet of the material 1 sq. ft. in area and weighing 0.43 lb. For birch, $h = 0.098$ in.; for spruce, $h = 0.153$ in.

Courtesy U. S. Plywood Corp.

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SHEET NUMBER . . . D-30
CLASSIFICATION . . Materials
SUB CLASSIFICATION . Continuous Cast Bronzes

Specifications for Ampoloy Continuous Cast Rod

THESE CONTINUOUS CAST BRONZES, adapted for use in automatic screw machines, are produced by continuous withdrawal through the bottom of a casting crucible, thence passing through a cooled die which gives required finish and accuracy.

Alloy	Tin Bronze 742	High Lead Bronze 382	Bearing Bronze 342
Sizes available	¾-2" incl.	1⅛"-2" incl.	1⅛"-2" incl.
Diameter tolerances	+.004"−.006"	Tentatively ±.010"	
Length tolerances	90% of rods ± 1"	75% of rods ± 1"	
	Max. of 10% shorter—none under 4'	Max. of 25% shorter—none under 4'	
Straightness	¼" maximum arc depth in 5' length		
Tensile strength psi.	40,000	30,000	
Yield strength psi. ½% ext. under load	18,000	14,000	
Elong. 2"—%	14.0	12.0	
Rockwell	F 80 min.		
Brinell 500 kg.			45–65
Copper %	86–89	81–85	Balance
Tin	9–11	6.25–7.50	4.25–5.5
Zinc	1–3	2.00–4.00	.50 max.
Lead	.30 max.	6.00–8.00	18–22
Iron	.15 max.	.20 max.	.20 max.
Phosphorous	.05 max.	.03 max.	.05 max.
Nickel	.....	.50 max.	.25 max.
Antimony	.....	.25 max.	.....
Others	.25 max.	.35 max.	.25 max.

(Courtesy Ampco Metal, Inc.)

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THE AVIATION NEWS

BLAINE STUBBLEFIELD, Washington HERB POWELL, New York

CAA Converted to Meet Broad Postwar Needs; Assistant Administrators Now Head Services

. . . ATSC-GE conference reveals super-jet . . . "Spot" plan guides output of new personal craft . . . New non-transport ratings sought under CAR . . . House committee finishes airport bill hearings . . . High school aero courses keyed for postwar.

Reorganization of CAA has been completed "to meet the urgent problems of postwar expansion in civil aviation activities, both foreign and domestic," according to T. P. Wright, administrator.

New setup further decentralizes CAA and provides for determination of policies, procedures, and standards in Washington, with the Administration in the field. Idea is to put CAA services within easy reach of all in aviation.

Principal change is in the designation of assistant administrators in charge of new and existing services, who will have responsibility for technical and administrative policies and programs. Under these assistants, directors of various services will organize their own activities in accordance with the new plan.

On the administrator's personal staff are four advisory committees and four special assistants reporting directly to him. The committees are: Non-Scheduled Flying, Commerce-CAA State Legislation, Statistical Coordination, and Executive Coordination.

Special assistants are: Edward M. Sturhahn, executive assistant to the administrator; John H. Geisse, personal flying; Dean R. Brimhall, research; and E. J. Robins, state relations.

ATSC-GE Conference Reveals Super-Jet

General Electric's new super-jet, called the "most powerful aircraft engine in the world, which now drives the Lockheed P-80 faster than any other plane will fly", was shown reporters for the first time at conclusion of a three-day conference on jet propulsion at Swampscott, Mass., attended by some 200 power plant and airframe engineers. Sponsored by ATSC and GE, conference was designed to "stimulate new advances in jet propulsion and gas turbines through pooling of facts and ideas", and appeared to bring a veritable contest among participants to see who could make the most optimistic predictions.

Typical were prognostications of R. G. Standerwick, GE engineer who directed design and development of the super-jet, who forecast that transcontinental passenger planes would be jet propelled within five years, and of Brig. Gen. L. C. Craigie, Deputy Chief of

Coming Up

(Meetings and dates subject to wartime conditions under ODT regulations)

July 30: Executive Committee Meeting, International Air Transport Assn., Paris.

Aug. 16 - 17: IAS Los Angeles Meeting.

Sept. 2: Interhemisphere Conference on Frequency Allocations and Revisions, Rio de Janeiro. (Postponed from June 2.)

Oct. 4 - 5: IAS Light Aircraft Meeting, Detroit.

Oct. 4 and Nov. 1: SAE Southern California Section Aeronautic Meeting, Hotel Biltmore, Los Angeles.

Oct. 15 (tentative): First Annual Meeting, International Air Transport Assn., Montreal.

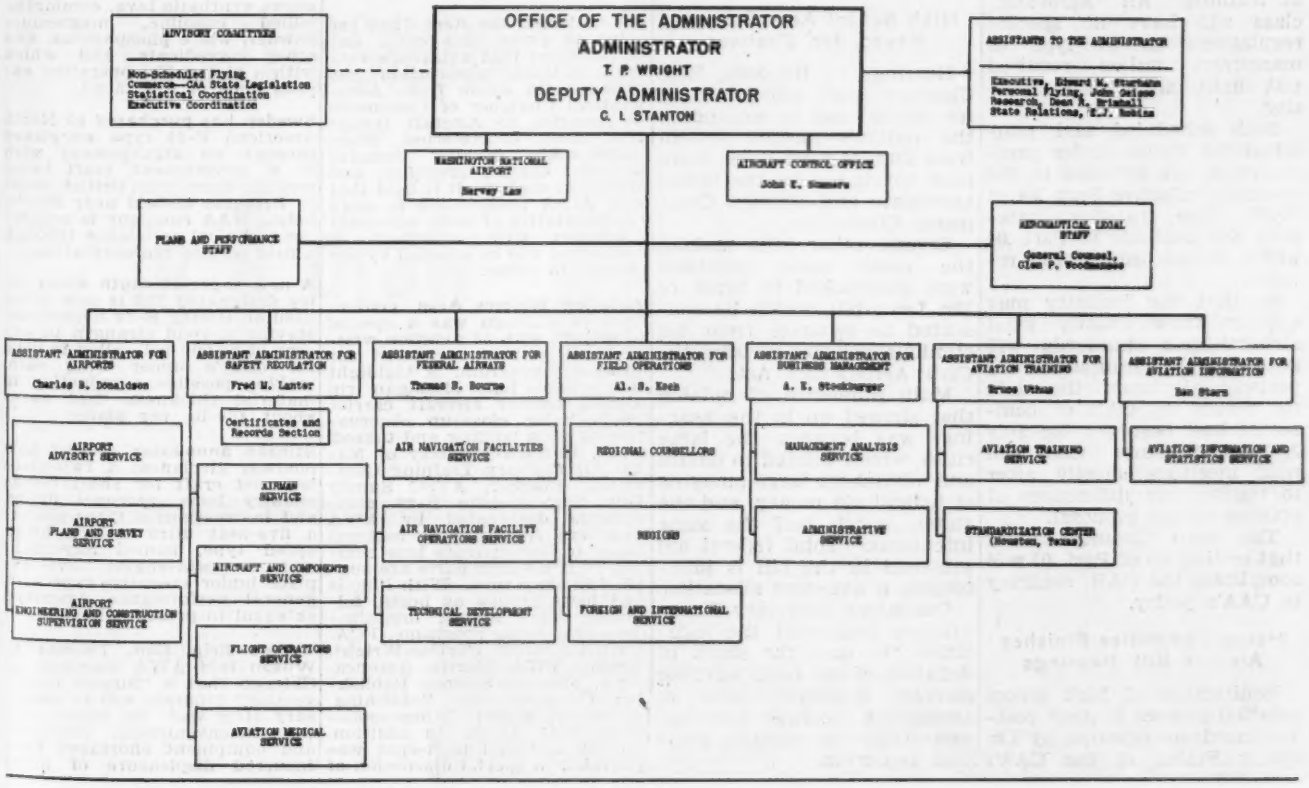
Oct. 26: IAS Washington Meeting.

Oct. 31 - Nov. 3: 1945 National Aviation Clinic, Oklahoma City. (Pre-clinic conferences start Oct. 27.)

Nov. 16: IAS Engine & Accessories Meeting, Dayton.

Dec. 17: IAS Wright Brothers Lecture, Washington, D. C.

DEPARTMENT OF COMMERCE
CIVIL AERONAUTICS ADMINISTRATION
ORGANIZATION CHART



ATSC Engineering div., who said, "We have within reach a new concept of military airplanes which will render obsolete and impotent the military airplane which played such an important role in the defeat of Germany".

All details as to performance, design, and construction of the super-jet remain restricted.

"Spot" Plan Guides Output Of New Personal Craft

Production of personal type airplanes has been authorized by WPB with priority assistance under the "spot authorization" plan. This means that assistance will be given only when production does not interfere with the war effort.

It is believed that the difficulty of getting certain materials and components will only permit manufacture of a few personal craft until late this year.

However, Limitation Order L-48, limiting the transfer and manufacture of civilian airplanes, has been revoked, hence producers are now on their own initiative.

New Non-Transport Ratings Sought Under CAR

CAB has distributed for comment a new proposed Part .03 of CAR establishing airworthiness standards for planes in non-transport categories.

"Special Personal" category is intended for personal planes; "Normal" includes craft for passenger or cargo operations; and "Utility" covers planes used for normal flying and limited acrobatics in training. An "Acrobatic" class will have no specific regulations as to type of maneuvers unless required test flights show such necessity.

Both scheduled and non-scheduled flying, under present rules, are included in the presently effective Part .04 of CAR. The transport category will continue in Part .04 which is also undergoing revision.

So that the industry may quickly know exactly what airworthiness standards will govern the manufacture of postwar airplanes, the date for return to CAB of comments had been set for July 2, 1945 or before. CAB will hold meetings shortly after to resolve any differences of opinion on the proposal.

The Aero Chamber holds that setting up of Part .03 will complicate the CAR, contrary to CAA's policy.

House Committee Finishes Airport Bill Hearings

Redirection of high school aviation courses to meet postwar needs is reported by Dr. Edgar Fuller, of the CAA's Aviation Education Service. Twelve states and the District of Columbia, covering 43% of the population of the U. S., now have formulated comprehensive programs for this purpose.

In Massachusetts, 152 of the state's 253 public high schools have regular aviation courses this year, enrolling 4,023 students. Connecticut and also Rhode Island show slightly higher percentages. Tennessee currently has 371 high school students from 45 institutions taking four hours of flying as "laboratory work" in the curricula.

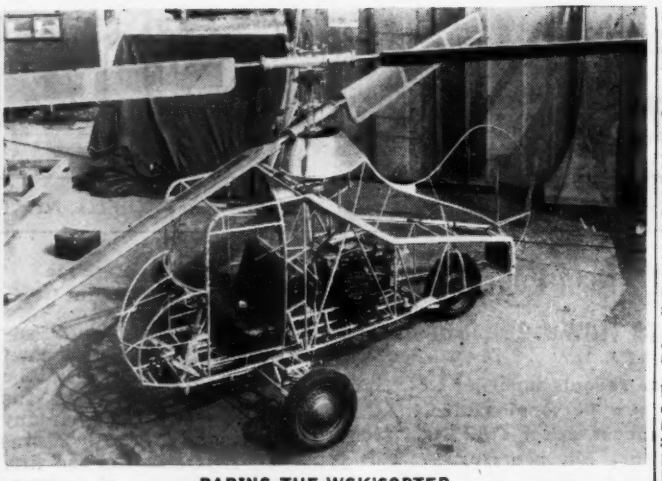
High School Aero Courses Keyed for Postwar

Hearings on HR-3170, Rep. Clarence Lea's bill providing for federal aid in expanding the nation's airport system from 3,000 to 6,000 fields, have been concluded by the House Interstate and Foreign Commerce Committee.

Several other bills making the same basic provision were sidetracked in favor of Mr. Lea's bill, which he consented to separate from his omnibus measure revising the Civil Aeronautics Act.

Main difference of opinion that showed up in the hearings was between the large cities, which wanted to obtain and administer large amounts of federal aid money, and the states, which had the same intentions. Total federal aid proposed in the bill is $650,000,000, a five-year allocation.

Commerce Secretary Henry Wallace supported the legislation "to ease the shock of deflation of our huge wartime aircraft industry", and to strengthen postwar economy and utilize our warborn aviation resources.



BARING THE WCK'COPTER

First photo of WCK'copter Flymobile, developed by Curtiss Wright Industries, Los Angeles, gives detailed skeleton view of new craft, which is scheduled for test flights as we go to press. A single seater, it is of metal construction with wood fairing strips and fabric covering. A 90-hp. Franklin engine turns 25 ft. dia. four-blade co-axial rotor at an estimated 325 cruising rpm., giving craft top speed of about 95 mph. Gross weight is approximately 1,100 lb. Design of three-wheel landing gear seems to indicate that Flymobile is also roadable.

The Feeder Airlines Assn. advocated extension of short-line services, with airports to accommodate them. The U. S. Chamber of Commerce warned against the provision which would permit municipalities and other project sponsors to deal directly with federal authority. E. E. Wilson, Aero Chamber president, said the country should provide opportunity for returning airmen primarily by making the fields attractive as personal enterprises.

★ SPOT CHECKING ★

It's no longer the Aero Chamber —for at press time came announcement that aviation's veteran national association has changed its name from Aeronautical Chamber of Commerce of America to Aircraft Industries Assn. of America. Since membership broadly includes aircraft, engine, propeller, and accessory makers, it is held that new AIAA designation is more representative of body, also past confusion with chambers of commerce will be avoided by the change in name.

Aviation Writers Assn. conference in Chicago was a special of month, with 56 aviation writers and editors registered for three-day program. A highlight was group's Lake Michigan trip aboard trainer aircraft carrier "Sable" for close-up observation of deck landing and takeoff work, through courtesy of Naval Air Primary Training Command. Further, ATSC Supply Div. flew specific B-29 components designated by AWA members, from various national bases to demonstrate how combat craft needing parts are supplied in snap time. With Illinois and local groups as hosts, following were among organizations presenting programs: PCA, United Aircraft, Curtiss-Wright, Boeing, TWA, Martin, Aeronca, PAA, Popular Science Publishing, Crowell-Collier Publishing, Goodyear, Sperry, Minneapolis-Honeywell, Alcoa. In addition, an international high-spot was provided in special discussion of air might by Britain's Air Marshal Collyer. In business session, AWA named Maurice Roddy, *Chicago Times*, as new president; James Strebig, AP, first v. p.; Phil Andrews, Andrews Publishing, second v. p.; Devon Francis, Popular Science Publishing, secretary; and Leslie Spencer, McCann-Erickson advertising, treasurer. Retiring prexy, George Haddaway, of *Southern Flight*, assumes duties as head of board of governors. For supplying air transportation which made conference possible, Troop Carrier Command was particularly hailed by membership.

Aircraft Engine Research Laboratory, NACA's $24,000,000, 15-building installation at Cleveland Airport, was initially opened to press when AWA group flew in from Chicago following association conference. In a program notable for its explicit presentations, members saw highlight work of laboratory. Included in demonstrations were fuel investigation on B-24, turbine materials research, impinging jets carburetor nozzle bar, fuel vapor loss study, exhaust valve cooling research, compressor impeller stress studies, axial flow compressor, combustion investigation with NACA high-speed camera, jet propulsion combustion research, fuels synthesis, altitude wind tunnel, icing research tunnel, intermittent ram jet propulsion, and jet propulsion engine research. Prior to laboratory tour, group visited Thompson Products plant.

AAF has released some data on fire-bombs, being used so effectively to burn-out Jap industry. Included are: M69, a 6-lb. missile filled with jellied gasoline, dropped in aimable clusters, opening in mid-air by means of a time fuse; M47, a 100-lb. bomb dropped singly, also containing jellied gasoline, which is thin-walled and scatters chunks of fire 40 yd.; M76, or "goop" bomb, a 500-lb. blockburner, which in addition to jellied gasoline, embodies powdered magnesium, liquid asphalt, and other ingredients which on impact combine to form a synthetic lava; and M74, a 10-lb. tubular type which spews synthetic lava, combining jellied gasoline, magnesium powder, white phosphorous, and other ingredients, and which with a piston-like operation expells gobs of fire 25 yd.

Sweden has purchased 50 North American P-51 type warplanes through an arrangement with U. S. government, craft being recently flown from British bases to Bromma airfield near Stockholm. NAA company is supplying technical assistance through a field service representative.

A new super-strength Alcoa alloy designated 75S is now being used on Boeing B-29 Superforts. Having a yield strength in excess of 60,000 psi., alloy is used for craft's upper wing skin, making possible a reduction in material thickness that saves about 400-lb. per plane.

Stinson announces several new postwar airplanes: A two-place low-cost craft for short cross-country hops, personal flying, and instruction; a three-placer; a five-seat ultra-modern high-speed type, named Skycoach; and a twin-engine five-six-place junior executive type with general performance described as equal to present airliners.

TWA's Brig. Gen. Thomas B. Wilson told AWA members at Chicago that a "human reconversion" program will be necessary after war. He stated that war inconveniences, priorities, and equipment shortages have incurred displeasure of many

ONE of the advantages of magnesium alloy sheet is the unusual depth to which it may be drawn *in one operation* at an elevated temperature. This wing gun fairing is a good example. The overall length of the fairing is 35". The width at its widest point is 10½". The depth of draw is 11".

This unit was produced in one draw at a temperature of 550°F., using heated tools, on a 200-ton hydraulic press. All experienced sheet metal men will recognize the exceptional nature of these results, which could scarcely be duplicated with other structural metals.

To the high strength-weight ratio of magnesium alloys, and their excellent weldability and machinability, can be added the speed and economy with which deep drawn shapes can be produced. In large-scale production, this feature alone may dictate the use of magnesium.

Revere magnesium sheet is available in three alloys, either hard rolled or annealed, providing a wide range of mechanical properties and working characteristics. Magnesium is available without restriction, subject to the prior claims of war production. Your priority rating will help to expedite deliveries. For full information on magnesium alloy sheet and plate, tube, rod, bar, extruded shapes and forgings, call the nearest Revere office. A Revere Technical Advisor will gladly consult with you.

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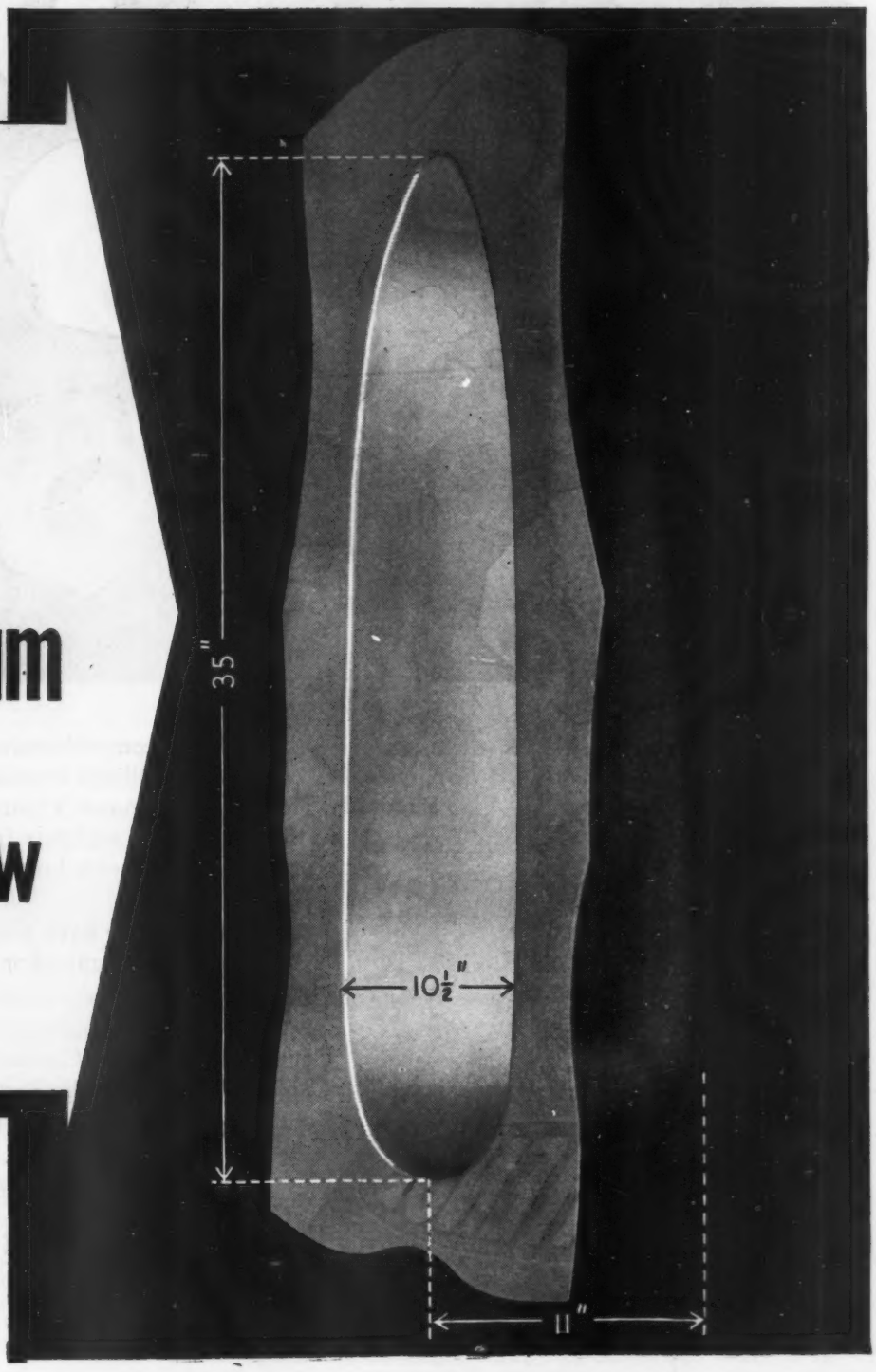

The deep drawn magnesium shape as it comes from the press. Fabricated by Brooks & Perkins, Donovan Building, Detroit, Michigan.

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customers, and that a reselling job will have to be done, with personalized service restored to previous standards.

Late Milo Burcham, former Lockheed test pilot, has been posthumously awarded Air Medal for "meritorious achievement while participating in aerial flights from 1937-1944".

AAF will soon put into use new test laboratory at Wright Field wherein temperatures of —110 deg. F. can be attained in order to learn about weatherproofing fighting planes for action in world's coldest regions. Unit will consist of four test chambers using three types of refrigeration compressors.

Turbo-electric propulsion was subject of talk by Austin F. Trumbull, UAL representative with Douglas Aircraft, at recent SAE meeting. He stated that preliminary engineering investigations suggested that aircraft powered by electric-turbines, might offer substantial savings in weight and power due to reduced drag and more efficient propeller locations. Another prediction was that within 5-10 yr., electrical loads of planes will range up to 25,000 kw.

It's stated that every 15 min. a military plane takes off from a West Coast airport for a trans-Pacific flight, and that every 13 min. an AAF cargo or passenger plane heads eastward over Atlantic. During peak operations in CBI, planes have passed over "Hump" only 3.5 min. apart.

Lockheed reveals that company submitted a jet-propelled fighter design to AAF in 1941, but need for production of conventional types delayed project. Also revealed is fact that P-80A is larger and heavier than XP-80, which was powered by a British-designed jet engine.

AAF states that more than 300 ATC craft will fly in and out of Miami Army Air Field as part of ATC's job of flying 50,000 overseas veterans to U. S. each month. C-47's are to land at field every 45 min. on a 24-hr. basis. It is estimated that craft will use more than 1,000,000 gal. of gasoline and 55,000 gal. of oil in one month.

New 50-cal. machine gun, capable of shooting 1,200 rounds per minute, has been perfected by Army Ordnance and Frigidaire div. of GM. Fire rate is increased 50% over previous types.

Great interest of public in aviation, bidding fair for postwar business, was indicated by two-day War Bond air show at Westchester County Airport, N. Y., which drew more than 40,000 spectators.

Fourth transcontinental airline went into operation when NWA came into La Guardia Field, N. Y., from airline's former terminus at Milwaukee. NWA also hopes to establish routes from Seattle to Hawaii, and to Orient via Alaska.

Atlantic security regulations have been relaxed so commercial airplane arrivals and departures are now made public. PAA is permitted to reveal that company transported 61,000 war passengers since Dec. 7, 1941, flew patrol bombers for Navy, provided Navy with flight engineer training programs, gave enemy sub recognition training, and flew 2,200,000 mi. on special missions.

AAF is now operating a regular service from Maine to Stockholm, Sweden.

ATSC's N. Y. Regional Office, Eastern District, at 1 Park Ave., N. Y. C., has been closed and functions and personnel transferred to Eastern District Hq., 67 Broad St., N. Y. C.

Jet-propelled transports travelling at over 1,500 mph. at altitudes of 100 mi. were predicted for 1955 by Lockheed's Chief Engineer Hall Hibbard.

Britain's government believes that responsibility for design and development of airplanes rests entirely with aircraft industry, says G. M. H. Nash, of British Ministry of Aircraft Production.

With engines running entire time to keep planes facing into wind, a group of Martin PBM Mariners recently rode 35-ft. waves and bucked 100-mph. winds for 20 hr. to ride out a South Pacific tropical storm at moorings. Crews aboard had to "fly" craft for storm's duration.

Trans-Atlantic waiting list of about 2,500 passengers has been built up by PAA since 1941.

Further developing school's aero program, Purdue offers short courses this summer for high school teachers.

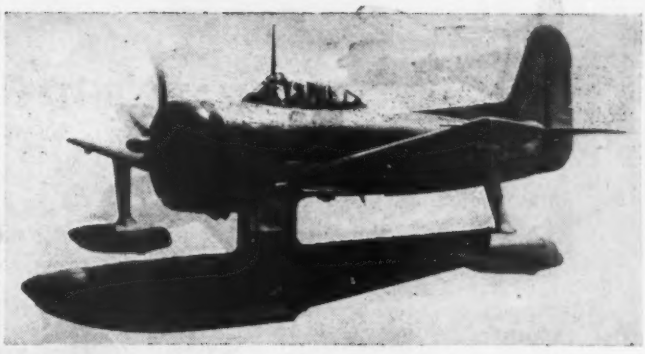
A shortage of technical and scientific men will handicap postwar expansion of industrial research, stated R. J. Dearborn, pres. of Texaco Development Corp. He said that war has taken trained men and stopped normal flow of research-headed students to colleges.

Senate has voted Medal of Honor and promotion to Major General rank posthumously to late Col. William "Billy" Mitchell. Legislation has been sent to House for approval.

AAF's A-14 oxygen mask is now also used during ditching. Experiments have shown that mask prevents strangling due to rough water. It enables crewman to swim under water beyond any fire, prevents face burns and breathing of fire, makes possible successful handling of unconscious persons under water, and permits escape from submerged crashed planes.

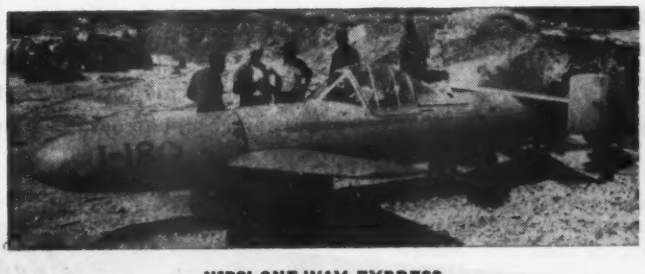
Publications: To serve aviation in Latin America, Turco Products, Los Angeles, offers 36-page booklet in Spanish for airline operators and maintenance engineers. Essentially a service manual, booklet gives information on modern chemical methods on exterior plane mainteance, engine overhaul, corrosion prevention, plating operations and airport maintenance, and is available without cost on letterhead request . . . "Wartime Technological Developments" is title of a report prepared by U. S. Bureau of Labor Statistics for Senate Military Affairs Subcommittee. Aviation developments cover 63 pages, and added sections cover aviation gasoline and metals. Included are short-cuts and new methods of manufacture in airframe, engine, propeller, and glider fields . . . N. Y. C. Dept. of Marine & Aviation has issued attractive booklet containing plans, data, and illustrations of new Idlewild Municipal Airport . . . Dept. of Labor is issuing a series of safety charts depicting work hazards and dangerous work practices. Thus far this year, monthly series has covered, industrial trucks, engine lathes, band saws, abrasive wheels, and shapers, respectively. To come in following months will be charts on ladders, wrenches, some electric hazards, arc welding equipment, and screw drivers. Charts are available from Government Printing Office, Supt. of Documents, Washington 25, D. C. at 5¢ per copy.

Errare humanum est: Due to an unfortunate similarity of sizes of plates, photo of Sikorsky R-6 helicopter was mistakenly printed on page 123 of June issue instead of intended flight shot of Aeronautical Products, Inc., helicopter . . . In May Aviation People page, purported photo of John L. Cohill, president of Firestone Aircraft Co., was instead photo of D. Anderson, company's new vice-pres., this error being caused by a misconstruing of photos and captions . . . New Product item No. 71, page 283 of our April number incorrectly specified Aro Equipment Corp.'s new drills as being electric. Correctly they are pneumatic.



NEW SEAHAWK SPOTTER JOINS NAVY

Here is Curtiss-Wright SC-1 Seahawk, single-seat single-float seaplane designed especially to operate with our fleet as a gunfire spotter and reconnaissance plane. Power plant is a Wright Cyclone 9, giving craft nearly three times horsepower of predecessor types, and Navy further says new SC-1 is twice as fast, can fly higher, farther, and has better armament than any previous models. Wing flaps and full span automatic slots bring craft's landing speed down to almost that of Kingfisher or Seagull. Curtiss four-blade hollow steel propeller is used. As a facility for search-rescue work, there is room in fuselage (behind pilot) to carry one man, and additional feature is bomb bay in float. (U. S. Navy photo)



NIPS' ONE-WAY EXPRESS

In this unusually clear photo are revealed design characteristics of Japs' notorious rocket-propelled "Baka" bomb. Found abandoned on Okinawa's Yontan airfield, odd craft has wingspan of about 16 ft., a length of 19 ft., weighs about 1,000 lb., and seats a pilot specially trained in suicide tactics. Usually carried to scene of action beneath a twin-engine Betty bomber, it is launched several miles from target and then directed by occupant against objective at speeds ranging up to 600 mph. Baka has proved to be one of most effective weapons in Japs' arsenal, even though high-ranking Navy spokesmen state that only an estimated 1 to 2% of flying missiles reach targets. (Press Assn. photo)

AMERICA AT WAR

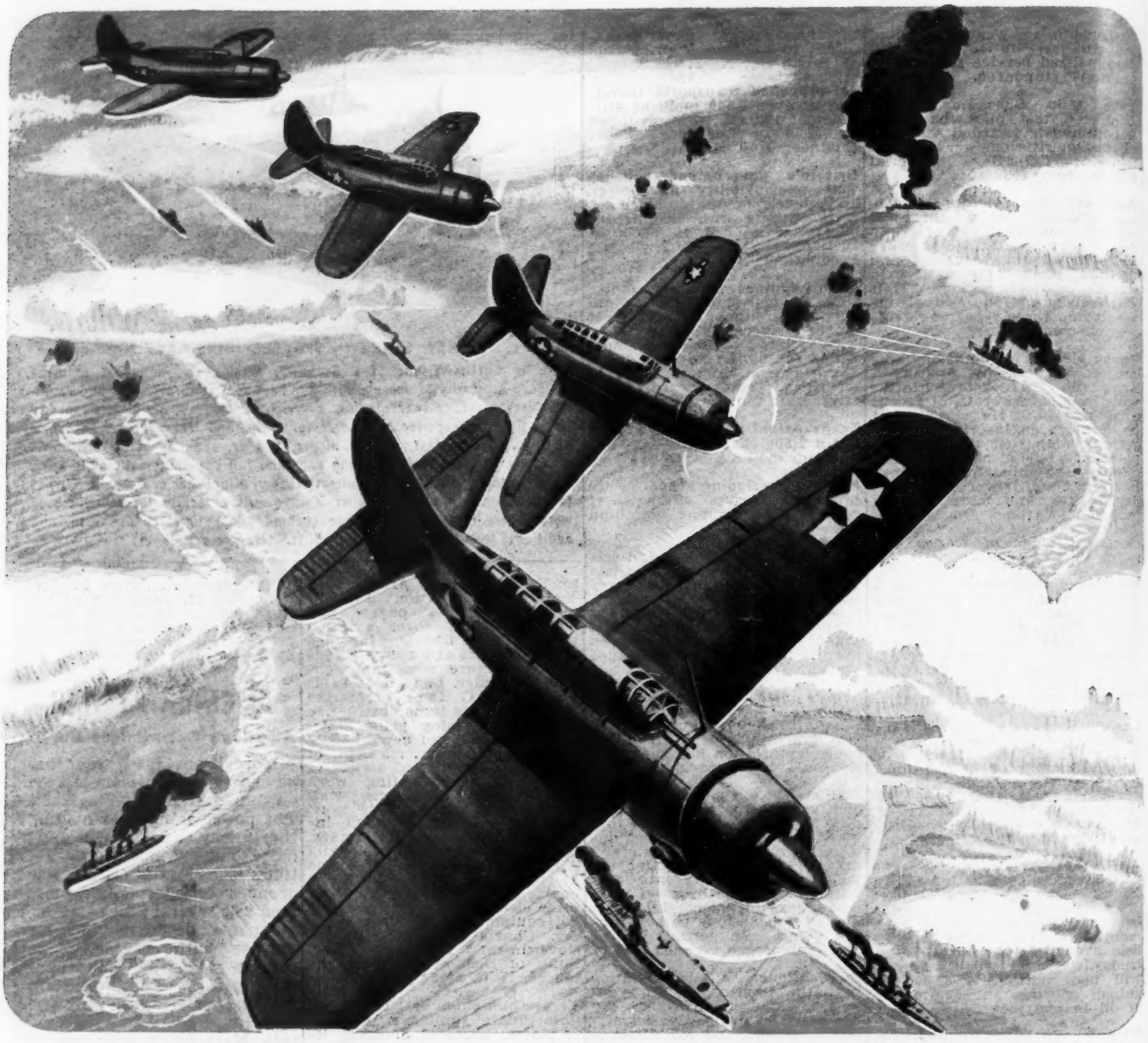
Aviation's Communique No. 42

More than half a year has passed since air war started on Japan from the Marianas. The power is on; it is hurting the enemy, and it will hurt more when Nippon gets 2½ times the tonnage that was dropped on Germany, whose area was several times greater.

Japan's desperate bid for defense with suicide pilots cannot slow the Allies, according to Vice Admiral Marc A. Mitscher. He said only one in a hundred planes that attack Navy craft ever get to their targets. Nevertheless, this form of attack has damaged many ships, killed many men, and required some redesign by Navy.

Navy pilots' reports that the Japs had come up with new fighters out-speeding the Corsairs, and with superior tactics, are discounted by Navy spokesmen. Tired pilots in tired planes, when attacked by a fresh enemy group, they say, often get pessimistic impressions. Even if the Japs had superior new designs, they could not build enough of them to have much effect. Furthermore, new and superior designs are on their way to our Navy air arm.

Pres. Truman, in his recent report to Congress, estimated Japanese air power at something over 3,000 combat planes. He probably means frontline equipment available for action. This would compare with German's top available air strength of about 5,000 planes. The President calculated Japan's monthly production of aircraft at 1,250



Helldivers from Heaven —

Take a look at "The Beast." Carrying one of the heaviest loads of destruction ever mounted in a single-engine plane, the Navy's newest dive bomber has speed, range and climbing ability along with its fire-power.

To gain these advantages its designers specified top quality equipment from nose to tail. A vital part of that equipment is the high and low tension wire and cable, made by Auto-Lite. If you have a wire problem, an inquiry will bring forms 838 and C-503A which describe these two wires in complete detail. Write to

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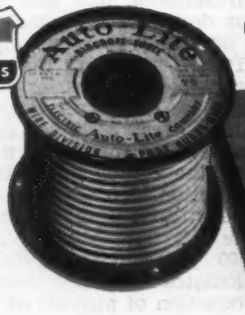


Aircraft AUTO-LITE WIRE & CABLE

to 1,500 per month at this time, despite a half year of American air attack on factories.

The President said his military policy is (1) to pin down Jap forces where they are, divide them, and destroy them piece by piece; (2) concentrate overwhelming power on each attacked segment; (3) use aircraft, ships, armor and artillery massively to save life; (4) apply relentless pressure so that the enemy cannot rest or reorganize.

Secretary Forrestal says Navy has three main tasks: (1) deliver men and supplies needed for present and future operations; (2) seal off the areas of attack in advance; (3) open up, support, and supply the beach-heads.

Many of the bombardment groups have already been moved from Europe to the Pacific. The powerful Eighth Air Force, which with the British RAF spread destruction over Naziland, will move across, and will be armed with B-29's, P-51's, P-47's, P-80's, and others now in the taper off stage. The British have moved in with carrier task forces. U. S. Navy reveals it has 26 carriers and 65 escort carriers in action (less those under repair) and is building more under forced draft.

Because Japan's production is extensively piece work in homes, whole cities are being systematically burned down. Scouts are already photographing smaller cities and towns. Experience has shown that, in many cases, fire keeps plants down longer than demolition by bombing; it warps machines so they cannot be re-installed. But fires do not burn well in certain kinds of weather, and explosives continue a major weapon.

Okinawa, taken at great cost of time and life, will be the most powerful advance base in the history of war. It is only 350 mi. from Jap mainlands, 972 mi. from Tokyo, short distances for late model planes. The island group can accommodate massive Army and Navy air forces.

The Japanese are already assuming the Nazi "fortress" defense attitude. Their navy has failed. Now their air forces are weakening, and the suicide technique is not improving their situation. Creditable thinkers believe the enemy may collapse in a matter of months under punishment from the air. But confidence in their hard-driving land forces, so long as those forces can get weapons and supplies, may keep Japan going for a long time.

★ CANADIAN NOTES ★

By James Montagnes

Since inception of War Assets Corp. last autumn, sales of Canadian surplus aircraft and equipment have totaled some $2,390,000 (to May 15). In this period 379 aircraft were sold for $1,390,000, of which 284 planes went for service outside of Canada. Aircraft equipment brought approximately $1,000,000. Recent sales included 2 Lockheeds, 6 Ansons, 17 DH Tiger Moths, and 2 Grumman Goose amphibians. These planes sold for $135,295, with seven going outside Canada.

Vancouver airport is to be enlarged as Canadian terminus of a Pacific route which is to meet an Australian service at a point somewhere in Pacific, according to W. F. English, v.-p. of TCA, which will operate route.

RCAF's personnel is being cut down from about 170,000 to 100,000. Latter number will be used for RCAF's participation in Pacific war, occupation service in Germany, and administrative work in Canada.

A central Canada air conference was held at Winnipeg recently to check with municipal authorities regarding postwar building of airports, air services, and need for immediate planning. Conference was called by Winnipeg Board of Trade, and speakers from Canada and U. S. discussed air problems with 400 municipal delegates who attended. Policy on disposal of surplus war-training airfields was urged on Ottawa. Delegates were informed of airfield needs of more than 400 Dominion municipalities, none of which has airport facilities of any kind.

★ CALLING NAMES ★

Bowman R. Otto, pres. of Otto Aviation, has been elected pres. of newly formed N. J. Aviation Trades Assn; **O. P. "Ted" Hebert** became v.-p.; **Walter R. Laudenslager**, secy.; and **Sandford W. Blackiston** became treas. **George Lambros, Jr.**, and **Joseph Schwanda**, with officers, comprise Board of Trustees.

John N. Gladden became pres. of Kinner Motors, succeeding **Earl Herring** who resigned to look after other interests.

Lee Miller was appointed mgr. of flight operations at C-W's Columbus, Ohio, plant; **Ed Grayson** became new staff asst. in company's sales publicity and promotion dept.

PAA appointments: **John E. Yerex** as regional mgr. for New England area; **Edmund L. Buckley, Jr.**, as district sales mgr. for San Juan; and **Edgar D. Hensley** as acting district sales mgr. in Los Angeles and Southwestern states.

R. L. Mussen has been made Convair's asst. div. mgr., and **F. L. Farrell** chief of contracts.

Joseph A. Uhl has been appointed asst. to pres. of CAL, and **Donald A. Duff** became exec. asst. in charge of airline's traffic and sales.

Ralph B. Smith was elected secy. of Menasco Mfg. Co.

TACA appointments: **Herbert A. May, Frederick M. Peyser, Webster B. Todd** and **John M. Lockhart** were elected to board of directors; **Harry Van Der Gaast** became purchasing agent; **James S. Hunter** was made new traffic mgr. at Miami; and **Henry I. McGee** joined company as gen. purchasing agent.

William T. Piper, Jr., became chairman, and **Carl Friedlander** vice chairman, of ACCA's PAC.

Beverly E. Howard, pres. of Hawthorne Corp., has been named a director of All American Aviation.

Solar Aircraft appointments: **E. E. Binger** became director of industrial relations of company's

(Continued on page 220)

★ OBITUARY ★

Laurence La Tourette Driggs, lecturer and author on aviation subjects. Learning to fly as early as 1913, he later was attached to RAF headquarters, and following World War I he investigated German aviation activities. He was organizer and first president of American Flying Club, and he also organized and commanded the New York National Guard 102nd Observation Squadron.

THE WASHINGTON WINDSOCK

By BLAINE STUBBLEFIELD

While Jap war factories are concentrated, making good bombing targets, millions do piece work in homes, which are being burned by AAF with new and fierce incendiaries.

One wishful rumor was true: Cities of the islands are highly inflammable. But each attack requires long careful planning as to proportion of fire and demolition bombs, and timing since last attack. Many things can go wrong; overcast, rain, wind, even humidity dampens fire to an amazing extent. Cold nights, though, enhance burning.

Leaders in Government and armed forces differ on how long air attack should continue before invasion. One group wants to take time for air war and save lives, other would wade in and get it over. Many believe aviation can batter the Japs down, but are wary after the German setback.

Balloon bombs from Nippon cannot hurt U. S. much, but their long range, silence, cheapness, and capability of creating public tension make them interesting possibility for use where prevailing winds, distance and density of population are favorable.

Hoorays for victory over Germany are held by some to be quite out of place. Fact that it took most of other military powers in the world to beat a little guy with a nutty gleam in his eye, and a country smaller than Texas, is sinister indeed, and deserves serious thought.

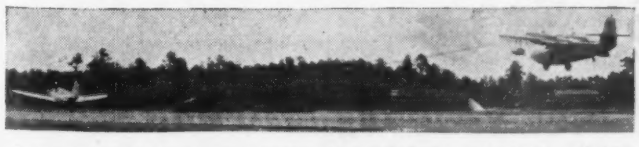
Army's revision of aircraft production schedule indicates confidence Japan can be polished off with progressively improved versions of existing designs, mainly four fighters: P-51, P-47, P-38 and P-80, and the B-29 and three transports: C-47, C-54, and C-46. Both Army and Navy are still developing new stuff, just in case.

Many leaders in non-scheduled aviation feel that the various groups must unite in presenting their claims to Washington. Scheduled air transport and military aeronautics demonstrated convincingly what can be done by coordinated effort.

An excellent war record and a promising future are the airlines' reward for their past years of effort and fair dealing. They are coming out of the conflict with organizations intact, with freedom of enterprise, and with their competitive forces still working.

GIVE HIM ENOUGH ROPE

. . . and a Curtiss Helldiver pilot can double in the job of plane towing, as was recently demonstrated by Navy men attached to Manteo Naval Auxiliary Air Station, N. C. A Grumman Widgeon required a change of engines, but facilities were not available to handle job at base. So engines and props were removed from Grumman, eye bolts were installed on ends



of two prop shafts, a "Y" harness and tow line were attached—and 325-mi. sky-haul to Johnsville, Pa., was made without much incident in 2 hr. 35 min. On arrival, Widgeon pilot cut loose from Helldiver and made a dead-stick landing.

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Army Plane Output Seen Dropping 17,000 Units Via 30-10-5 Cutback Plan; Navy Levels Pegged

. . . Production status noted on 10 types . . . Gage late developments on surplus craft front . . . May output: 6,354 planes . . . Check civil plane picture.

Army's announced combat aircraft cutback of 30% during the last half of 1945, and 10 and 5% in the two halves of 1946, can be drastically changed at any time. Anticipated progress in the war against Japan probably will bring additional large stop orders.

Meanwhile Navy's aircraft requirements continue at current levels. New aircraft carriers are constantly being commissioned and taking on new airplanes. The enemy at this stage of the war is able to inflict serious losses on Naval aviation.

On the basis of airframe weight, production for Army in the second half of 1945 will be about 70% of weight produced in the first half. Production in the first half of 1946 is projected to drop to 60%, in the second half to 55%. The total reduction in units is seen as about 17,000 airplanes.

Many Government, military, and airplane industry officials have complimented the industry for its important part in bringing Germany down. E. E. Wilson, president of the Aeronautical Chamber of Commerce, said the industry is ready to begin production of civilian transport and personal airplanes as soon as the national interest will permit. He called for continuation of aeronautical research at a high level. Donald Douglas, president of Douglas Aircraft, stated that the industry has built about 300,000 airplanes since President Roosevelt called for 50,000 craft in May of '40.

Gen. H. H. Arnold, chief of the Air Forces, praised the quality and quantity of aircraft produced, and said they had played a vital part in winning the European war. He said that tactical and strategic requirements have changed. The airplane attrition rate dropped in Europe as the Luftwaffe weakened, and many planes sent there will now fight Japan. Stop orders are due chiefly to curtailment of lend-lease deliveries.

Production Status Noted On 10 Types

Detail of cutback orders may change at any time, but it serves to show present air war trends. Nearly all Army combat types and nearly all U.S. cities building airplanes are affected. At this writing the production schedules of aircraft engines and propellers were being revised.

Consolidated B-32: To be discontinued at once at San Diego, and to be tapered at Fort Worth to termination by close of 1945.

Boeing B-17: To be tapered to about one-fourth present rate at Douglas Long Beach by this Fall. At Lockheed Burbank, production will terminate this Fall, chiefly to accommodate P-80 output.

Boeing B-29: Present production rate to increase for a while and then to be stabilized during last part of this year. Each plant producing B-29's will incorporate all modifications; employment will not be affected.

Douglas A-26: Continuing at Long Beach and tapering to termination at Tulsa by Jan. 1.

Bell P-63: To be cut by July and terminated in September; target trainer (shot at with frangible bullets) unchanged this year, reduced next.

Lockheed P-38: Tapering to zero by November; Consolidated at Nashville terminates after June.

Lockheed P-80: Will continue unchanged at Burbank; production at North American Kansas City, has been canceled.

Douglas C-47: Tapering to half present rate at Oklahoma City by year-end; to continue on that output level into the year 1946.

Beech C-45: Continue at current rate to Fall, then taper to about half, where it will stand into 1946.

Curtiss C-46: Now ending (June) at Louisville. St. Louis is also terminating, but will continue parts production. At Buffalo is continuing unchanged at this writing. but is to level off at two-thirds after August.

Gen. Arnold said that long-range types are wanted for the war on Japan. Army's statement does not mention the Consolidated B-24. North American B-25, P-51, Republic P-47, Martin B-25, and some others. Presumably no cutbacks have been planned for the new models of North American P-51, or for P-47, or for the Douglas C-54. The B-24 is already out at San Diego, and is terminating July 1 at Willow Run, where a unit has been rolling out every 55 min., making good Ford's objective of one per hour. Boeing at Renton is producing six B-29 Superfortresses per day.

Although man power is still tight in several plants, it is expected that layoffs for the industry as a whole may reach a percentage equal to the cutback in output.

Gage Late Developments On Surplus Craft Front

Confused direction of surplus aircraft disposal continues in Washington. Reconstruction Finance Corporation has now placed all surplus property functions under Hans Klugsbrunn, Defense Plant Corporation vice president, who has been heading the aviation part of the program. Joseph P. Woodlock is executive director. The Surplus Property Board now is directly under RFC, not DPC. James A. Garfield became deputy director, in charge of aircraft disposal.

Disposal of military aircraft overseas has been taken from the Foreign Economic Administration and is under the Army-Navy Liquidation Commission. ANLC was to have had aircraft, among other surplus war goods abroad, in the first place, but it was outmaneuvered by FEA. ANLC exercises policy-making powers, whereas the domestic Surplus Property Board is merely an administrative agency, whose policies are made by RFC, along with the Army and Navy.

Development by the Aluminum Co. of America of a successful process for salvaging pure aluminum from airframes (in a caustic soda bath which dissolves aluminum and leaves other metals untouched) may result in Government decision to return all surplus warplanes to this country for conversion into an aluminum stockpile for any future emergency.

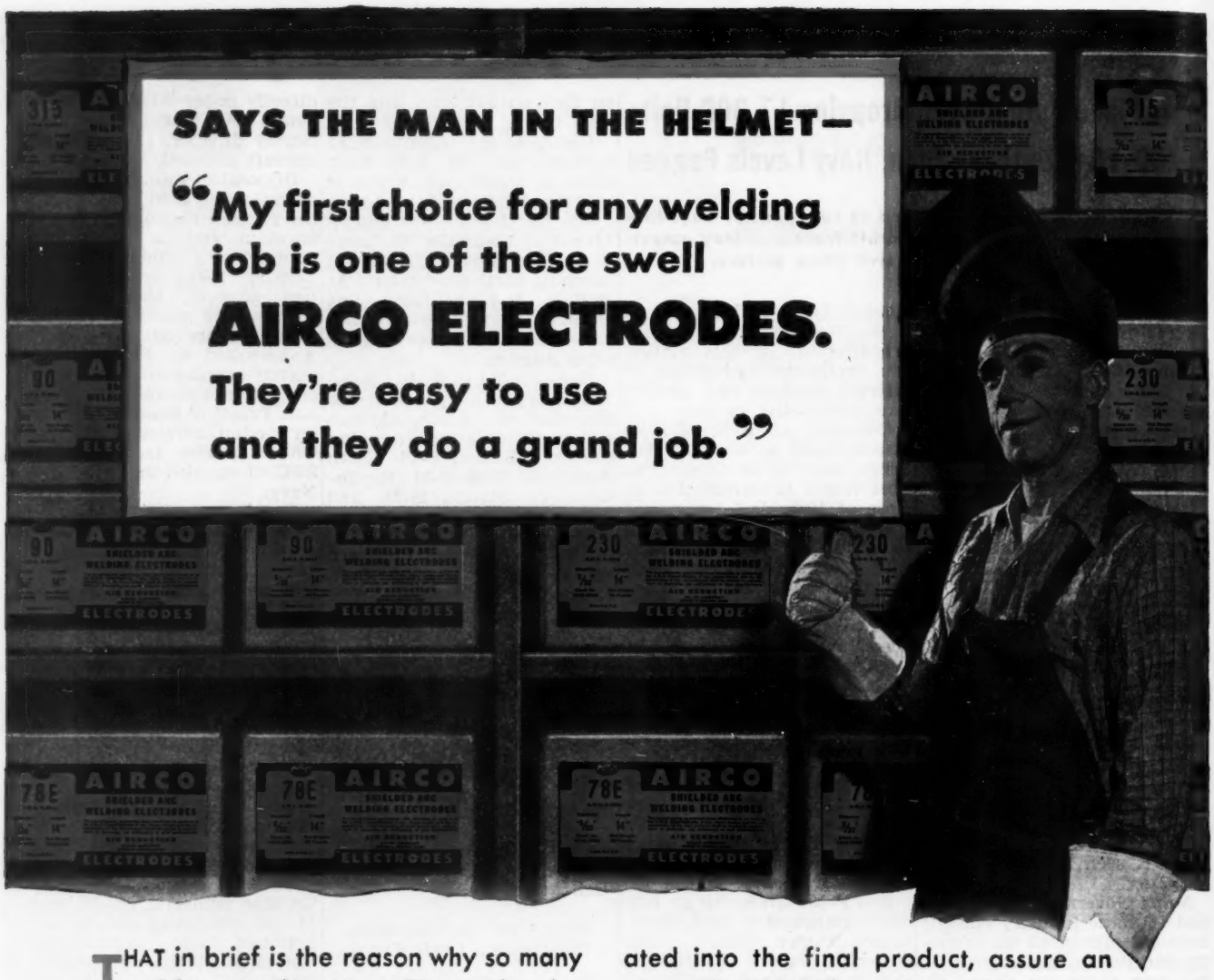
An estimated 30,000 schools and colleges appear to be eligible under an SPB regulation to purchase surplus military planes for educational purposes at prices ranging from $350 for B-17's to $100 for dive bombers; $1, $2, and $3 for indicators, brake assemblies, and carburetors. Shipping weights are stipulated and shipments are direct, when possible, from nearest storage point.

In general all desirable light liaison planes have been sold; there are plenty of less desirable trainers still on the market, however.

In the transport category only the Lockheed Lodestars (about 70) are available. Combat airplanes are useless for most civilian needs.

MAP AIRCRAFT STANDARDS PROGRESS

Members of National Aircraft Standards Committee are seen here at recent ninth semi-annual meeting in Hollywood, sponsored by Aero Chamber of Commerce. Standing, left to right, are: W. V. Stackhouse, North American; J. Townsend, Hughes; L. J. Catlin, Douglas; J. F. Shirtzinger, Douglas; V. G. Mellquist, ACCA; G. W. Baughman, Cessna; T. A. Erbe, Convair; W. H. Korff, Lockheed; D. W. Beck, Douglas; J. F. Cramer, Boeing; C. B. Sheckells, Douglas; E. A. Pinger, Convair; V. Tini, Hughes; E. Dudley, C-W; C. T. Torresen, North American; C. R. Watson, Beech; J. H. Wood, Ryan; J. Perina, Republic; W. E. Buffe, Goodyear; J. F. Hammond, Boeing; C. Sardou, Jr., Convair; E. H. Babel, Northrop; C. Schindler, Fairchild; G. T. Waite, Convair; H. R. Leader, Bell; C. E. Heywood, Vought; J. B. White, Lockheed; R. P. Roepke, McDonnell; E. W. Norris, ACCA; and M. P. Cameron, Lockheed. Seated, left to right, are: E. D. Graham, North American; T. P. Hearne, Ryan; Flt. Lt. D. G. Moffitt, RAF, British Air Commission; G. H. Nash, British Ministry of Aircraft Production; J. A. Drankowski, Fleetwings; J. T. Thompson, Martin, (NASC national chairman); G. M. Aron, Northrop; H. W. Zipp, Boeing; Lt. Comdr. J. J. Tigert, Aero Board; Lt. Col. G. R. Galliard, Aero Board; and W. V. Boughton, Douglas. (Hod Lewis Associates photo)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AIRCO **ELECTRODES** FOR BETTER WELDS AND EASIER WELDING

May Output: 6,354 Planes

Output of planes in Ma totaled 6,354, surpassing b nine units the number sched uled for the month. This wa the third month in which the quota had been topped. B comparison, April production was 6,412.

The drop from the previous month showed the influence of the ending of the war in Europe, with consequent les sened demands for certain type craft not slated for us against the Japs.

May output of bomber craft hit 2,168, 15 over the quota o 2,153. Total of trainers was 184, against 150 scheduled. On the other hand, fighter and reconnaissance craft summed to 3,019, 11 under the 3,030 called for. Transport types missed the 636 goal when but 617 were made, and the 366 special purpose planes were 10 short of the scheduled 376.

Check Civil Plane Picture

Aircraft manufacturers are free, under an Aircraft Production Board (WPB) order to begin to produce equipment for the airlines to such extent as does not interfere with the war. Great credit went to Henry Nelson, director of the Aircraft Division of WPB, and to manufacturers attending a Washington meeting, for securing the authorization, which carries an AA-2x priority. Army and Navy approved the program.

The airlines had asked for 321 planes; the figure was later raised to 364—205 four-engined and 159 two-engined units. Some are to be delivered in the last quarter of 1945, the rest in '46. Eighty percent are wanted by June 1946. RFC is authorizing the use of government - owned tools and other facilities in production of the planes.

Production of light airplanes was authorized on May 17 by revocation of WPB Order L-48 —that is, to such extent as does not hinder the war effort. There is no automatic priority for lightplanes, as for transports; the manufacturers have only "spot authorization" which may be withdrawn at any time. Priority assistance is provided for modification of surplus planes sold by RFC, but not many desirable types, except for training purposes, are offered.

★ KNOW HOWS ★

High-frequency low-voltage ignition by P. R. Mallory, Indianapolis, is said to fire evenly under extreme conditions of dirt and oiling. System has been tested with good results at 50,000 ft. altitude.

Synthetic rubber protective strips installed by U. S. Rubber Co., on helicopter rotor blades are reported by Coast Guard to prolong rotor life indefinitely, under rain abrasion, as against damage after 10 min. for unprotected units.

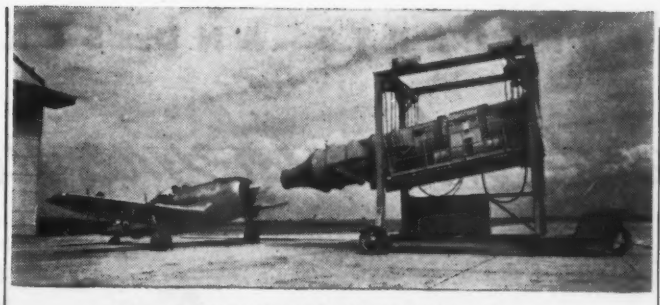
Mike control switch installed in gun mount on B-17's by UAL is estimated to have saved over 21,000 man-hours per year in wiring time and servicing.

Electronic sequence timer, developed by ATSC after being told it was impossible, will make six exposures in 3/10,000 sec., reports Wright Field.

Using phenol-formaldehyde resin adhesive by Resinous Products & Chemical Co., moulded plywood aero lifeboats weighing 3,100 lb. are being made by Higgins Plastics Co., of New Orleans.

Selenium rectifiers with 85% efficiency are now being designed by G-E for converting single- or polyphase current to d.c.

Clamps now being used by Glenn L. Martin instead of burlap for plaster mold corners have resulted in considerable time saving and increased efficiency.



NACA'S "OUTDOOR WIND TUNNEL"

This mammoth portable blower is used to send high-speed airstreams into revving power plants of chocked-down aircraft, thus simulating test flight conditions without need for plane leaving ground. Massive unit, seen here in action with Republic P-47N, is capable of producing 250-mph. airspeed. Blower's fan action enables operation of test engines at maximum takeoff hp., accordingly eliminates dangers of takeoffs with untried engines. Furthermore, blower is invaluable research tool, making possible numerous studies, such as of cooling of fully installed power plants. NACA's Aircraft Engine Research Laboratory at Cleveland initially revealed this equipment to press on occasion of recent inspection tour by Aviation Writers Assn.

★ FOR THE RECORD ★

Republic Aviation has opened a permanent N.Y.C. engineering office at 42 Broadway in order to speed up essential experimental projects.

Alabama Institute of Aero has sold interests in Hargrove Van De Graff Field to Dixie Air, Inc. Field houses a fixed base operator and has a resident flight school for young women. Raymond Collin will be in charge.

Trimount Instrument Co., 37 W. Van Buren St., Chicago, has been licensed by Convair to build Convair-designed 50-tube inclined tube manometer for wind tunnel research. Divisions on instrument's scale are horizontal, from 1-10 in. calibrated in tenths, and stated to make possible very high accuracies. Walls are aluminum or stainless steel, and unusual tube and well arrangement is said to be leakproof. Instrument is relatively light, compact and portable.

Bendix Aviation Corp., Pacific Div. has opened a sales-engineering office in Continental Building, St. Louis, Mo. Harold W. Bailey and William P. Harrison have been appointed sales-engineers in new office.

Zimmer-Thomson Corp., 29-05 Review Ave., Long Island City, has changed corporate name to Thomson Industries, Inc. Company makes Iso-Rev constant-speed propellers, Thriftmaster multiple spindle drillheads and Ball Bushing longitudinal reciprocating bearings.

GE's research laboratory will be enlarged by a new building costing $8,000,000 in suburban Niskayuna, about four-and-a-half mi. from main plant and offices in Schenectady, N. Y.

Rockford Clutch Div. of Borg-Warner opened new engineering laboratories in Rockford, Ill.

Gothard Mfg. Co., Springfield, Ill., is having a new plant built, which will furnish enlargement of company's engineering and research departments in addition to increased manufacturing space. Company makes pilot light assemblies for electronic and electrical equipment, and appliances.

Buchanan Research Laboratories, Inc., 2 West Jersey St., Elizabeth, N. J., is newly formed organization headed by Stephan N. Buchanan. Concern does research and development in radio, telephone, television, aircraft and commercial wiring uses.

The Instrument Society of America is a new national society formed to advance arts and sciences connected with design, manufacture and use of instruments. Elected pres. was A. F. Sperry, while C. F. Kayan was made v.-p.; C. E. Fry became treas.; and Richard Rimbach was made secy. Office of secy. is society's temporary office and is at 1117 Wolfendale St., Pittsburgh, Penn.

Linear, Inc., is new name of Linear Packing & Rubber Co., State Rd. & Levick St., Tacony, Phila., Pa. Concern makes hydraulic seals used on airplane hydraulic systems.

KNILM has located new offices at 521 Fifth Ave., N. Y. C., Room 1008.

New Aviation Products Div. has been formed by Goodyear Tire & Rubber, and R. W. Richardson was appointed mgr. Tire, wheel, and brake sales for airplanes, formerly part of Aviation Sales Div. of Government Sales, and former Aviation Products Dept., will become part of new division, which combines all related activities of company.

O. L. Woodson Co., 714 W. Olympic Blvd., Los Angeles 15, is newly formed industrial service to develop products, production methods, plant facilities, and general management. Organization has been associated with Northrop, C-W, Chance Vought, Bell, and Ryan.

GE plans to establish a new base at Schenectady County Airport, N. Y., where company's flying laboratories will test scientific and mechanical developments, including jet engines and gas turbines for airplanes. It is stated that work on a hangar and ground laboratory will begin immediately. Building will be 160 ft. wide, 180 ft. long, and 45 ft. high at center.

Allied Appliance & Plastic Co. is new name of Allied Appliance Co., 1014 N. La Brea Ave., Los Angeles 38. Company, which specializes in making aircraft and automotive valves, fittings, and other automatic machine products, has added a plastics div. to design, fabricate, and mold parts. Chief is R. B. Gutsch.

★ ASSEMBLY LINES ★

Convair has made 9,468 Liberator B-24s. Of total, 6,725 were made at San Diego plant and 2,743 were built at Fort Worth. In addition, company turned out spare parts equal to 1,138 more bombers. During war, company has made 36,289 planes counting spares, representing 375,000,000 lb. and 14 different types.

Lend-Lease: U. S. has shipped 13,300 planes to Russia and 9,500 to United Kingdom. Total of $5,618,618,000 was spent on shipment of planes, engines, and parts to all of Allies.

C-W stated corp. will close St. Louis plant and concentrate production at Buffalo and Columbus. Wright Aero's schedules will represent, by next June, a 50% increase in engine production over level of early this year. More than 123,000 Cyclones had been built for European phase of war.

Northrop's veterans' hospital program has achieved 100,000 hr. of work without a single industrial accident or even a first aid injury.

Douglas has turned out 10,000th DC-3 transport, with all but 500 made since Pearl Harbor. Craft are now only built at Oklahoma City plant.

Willow Run plant is stated to be turning out a complete B-24 every 55 min. of working time, and recently passed a total mark of 8,500 of craft. Production is now on one eight-hour shift.

Total of 10,000 Vought Corsairs have been built: Vought has made more than 6,000; Goodyear has made over 3,000; and 735 were built by Brewster.

Boeing's Seattle-Renton plants expect to reach peak production on B-29 Superfort this Summer. Renton plant is turning out six bombers a day.

Georgia ATSC depot has reduced time to overhaul each P&W R-2800 engine from 350 to 250 man-hours per engine; has cut time to overhaul Boeing B-17 by 2,125 man-hours. Depot reports annual savings of more than 2,500,000 man-hours have been made, plus $160,000 yearly in operational costs through changes in policy on construction and repair work.

Detroit Gear Div. of Borg-Warner has made 250,000 aircraft vacuum pumps since Nov. 1941.

KINNER PARTS AND SERVICE

When and where they're needed!

With the return to private ownership of many hundreds of military training and other airplanes, new owners need to know if parts and service for airplane *and engine* are always available.

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1919 • Builder of Aircraft Engines for Over a Quarter Century • 1945

BUY MORE WAR BONDS

Airlines Get AA-2 Priority for New Planes; Authorization Includes Component Makers

. . . C-54 released for tests . . . ATA conference gets special traffic sections . . . AAF to release pilots for airline jobs . . . NE Phila. airport re-opening.

Airlines have been authorized by APB to order new planes with assistance of an AA-2 priority. Manufacturers are free of all restrictions on delivery of airliners except that military requirements must come first.

A schedule submitted by operators during a Washington meeting which resulted in the agreement, calls for 159 two-engine planes and 205 four-engine units, but as operators are expected to deal individually with producers, the schedule may come to have little meaning.

It is expected that a few new two-engine planes can be delivered this year, but no four-engine equipment can be turned out until next year.

Henry Nelson, director of WPB's aircraft division, was credited with a leading part in the agreement worked out with the Army, Navy, and WPB. Manufacturers called to Washington to take part, and the Aircraft Manufacturers Industry Advisory Committee, were surprised at the promptness and extent of their success.

Government-owned facilities and tools will be used in production of the airline planes. Cooperation of the RFC and of the Office of Surplus Property seems to be assured to that end.

The authorization, signed by WPB chairman J. A. Krug, included propeller, engine, and other component producers. The manufacturers were told that draft-exempt men must not be employed on these civilian orders. It is believed that most of the raw materials needed for airliners will be available.

C-54 Released For Tests.

AAF has released a Douglas C-54J, the AAF version of the DC-4, which is at present the four-engine leader on postwar airline order books, for test and airworthiness rating by CAA. The DC-4 series, initiated years before the war in a somewhat heavier design, has been a star in military air transport as the Army's C-54 and Navy's R5D, and much maintenance and operating experience has been built up in it. Craft is on postwar order by AA, UAL, PCA, EAL, NAL, NEA, WAL, and others.

The plane assigned for test has been used for that purpose by the AAF and is equipped with the necessary instruments. Several weeks of testing will be done by the Douglas Company at Santa Monica.

Many alterations will be made during trials, such as change of ailerons and flaps, and it is intended to cover as many C-54 variations as possible.

ATA Conference Gets Special Traffic Sections

Reorganization of ATA's Air Traffic Conference of America created three new specialized sections operating under an overall Assembly of Traffic Executives: (1) A passenger traffic section; (2) a cargo traffic section; and (3), a tariff publication bureau. These take place of the general conference which had previously handled all traffic matters.

Composed of the traffic heads of the 20 U. S. and 2 Canadian airlines, the overall Assembly is headed by Harold Crary, UAL vice-pres.-traffic; the Passenger Section, composed of passenger managers, has as its chairman Willis G. Lipscomb of AA; Cargo Section is headed by Harry Stringer of All-American Aviation; and Tariff will be operated as part of the conference with J. B. Walker as manager.

AAF to Release Pilots For Airline Jobs

To meet increasing air crew needs of the airlines, the Army has agreed to release a number of pilots and co-pilots. Applicants for release are being interviewed by prospective airlines, and personnel selected are given letters to submit with their discharge applications. Needed are at least 1,000 pilots and co-pilots.

During the past 15 months nearly 10,000 more route-miles have been authorized by CAB, together with resumption of many suspended schedules and stops. The airlines now have over 375 planes, as compared with 209 on May 1, 1941.

In addition, the airlines have been asked to pick up about 50,000 soldiers, whom the AAF will fly from Europe to the East Coast in 800 military transport planes, and set them down at their home towns for furloughs, then fly many to West Coast for embarkation to the Pacific combat theaters.

NE Phila. Airport Re-Opening

As we go to press it is announced that Northeast Philadelphia airport was scheduled to re-open on July 1st after a shut-down period beginning Dec. 1943. Howard Shafer is airport's new manager, and it is stated that nine airlines have applied to use field, which is 14-mi. from the city's Broad St. station. When fully completed, the new terminal will have cost $12,000,000.

★ CROSS COUNTRY ★

Inter-American Safety Council gave awards to 21 airlines serving South and Central America for operations in 1944 without accidents or fatalities. Among winners was AA de Mexico with 27,588,899 revenue passenger mi., and Pan-Am-Grace with subsidiary companies which totaled 68,014,116 mi.

AEA announced CAB authority for new $150 round-trip excursion rate for N. Y.-Botwood, Newfoundland flights. No priority is required. Sikorsky "Flying Ace" four-engined transatlantic flying boats are used.

PCA opened six-flights-daily service from La Guardia Field, with non-stop trips to Pittsburgh, three daily express flights to Chicago, and three to Birmingham. Transcontinental connections are made at Chicago and for Southwest on southern div.

CAL began operating on new schedules that increased monthly air mileage from 263,000 to 368,480 mi. New flights provide three round trips daily between Denver-Kansas City and Denver - Albuquerque. Denver - San Antonio route was increased to two round trips daily. Other additions include one plane service from Colorado Springs and Pueblo to Kansas City, and added flight between El Paso and San Antonio. Airline received permission for new air route linking El Paso with Tulsa.

Delta Air Lines began regular air express shipments of fresh sea food from Savannah and Charleston to Atlanta after CAB approved reduced rates of six cents a lb. Special container with compartments for dry ice was designed by airline.

ATA reports: Air transport expansion plans call for 678 new scheduled airline stops in U. S., totaling 794,296 mi. of routes. At end of first quarter of '45, 554 applications were pending for new domestic service, plus 100 applications for foreign service, covering 634,625 route mi., and there were 37 applications for new Alaskan operations. In '44 airlines in U. S. are stated to have handled 1,773,823 express packages, a total of 84,276,834 lb.

New, modern type airport terminal and administration building, to cost about $1,000,000 has been proposed in expansion of Lambert-St. Louis Municipal Airport. Plans call for airport enlargement to 1,400 acres.

Stated to be first recorded delivery of airborne asparagus, Ralph Myers, Calif. grower, sent 136 crates of asparagus, 20 crates of broccoli, and 5 crates of flowers, with total weight of 6,000 lb. via UAL to Carbone & Co., N. Y. C. Successive shipments have been made on Sundays when traffic is said to be light. Asparagus crates are specially designed to pyramid shape to custom fit contents. Weight saving is stated to be achieved by cutting two inches from asparagus butts, saving about 8-10 lb. per crate.

Braniff started service to Lubbock, Texas by making it a stop on airline's schedule between Denver and Texas points, and will operate from Dallas to Denver via Fort Worth, Lubbock, Amarillo, Pueblo and Colorado Springs. Airline is re-inaugurating service between Houston and Galveston, which had been suspended because of war conditions.

Formal leases for space at Idlewild Airport are expected to be signed soon, with at least a dozen of major U. S. airlines interested in new field. It is estimated that within 5 yr. after V-J, airport would be handling 900 daily flights, and in full operation field would provide for 30,000 passengers daily and require a staff of 40,000 men and women. Completed airport is to have twelve 6,000-11,200 ft. runways, each 200 ft. wide, and capable of taking planes weighing 150 tons. Final stage of construction is expected to be finished in 1950.

NWA has opened a central transportation control office at Minneapolis, with branch office at Billings, Mont., in order to expedite handling of passenger space. A plan is said to make it possible for company's ticket offices to be quickly informed as to seats available with minimum of communications between stations. The control office assigns

SHETLAND—BIGGEST BRITISH BOAT

New 65-ton Shetland flying boat is joint Short and Saunders-Roe design, powered by four 2,500-hp. Bristol Centaurus 18-cyl. radial sleeve-valve engines. Seen here is military version, but construction has already started on commercial model, which is to accommodate 70 passengers and a crew of eleven. Freight compartments will have a capacity of 6,600 lb. of cargo or mail. Craft has a 150 ft. span and is 110 ft. long. Cruising at 184 mph. and carrying 7,620 lb. payload, it is stated range will be 4,650 mi. Fuel capacity is 6,112 gal. (British Combine photo)

HOW TO GET EXTRA ADVANTAGES from *Carpenter* Stainless Tubing . . .

When your special design or fabricating needs call for an extra amount of "know-how", rely on Carpenter's experience with Welded Stainless Tubing. Put that experience to work on *your* engineering problems. Use it to help you make full use of the advantages of Welded Stainless Tubing. Use it to actually multiply those advantages.

HERE'S A TYPICAL EXAMPLE

of how one manufacturer put Carpenter's experience to work . . . profitably. The problem was to make this X-Ray tube unit with a sealed-in-glass tubular member. With Carpenter's help, tubes of the proper analysis were provided and a difficult engineering problem was solved.

MORE AND MORE—IT'S CARPENTER WELDED STAINLESS TUBING FOR . . .

- uniform tube walls—no thin spots
- easy bending, expanding, etc.
- higher strength/weight ratio
- cold-rolled surfaces inside and out
- lower first cost
- lower fabricating costs
- heat and corrosion resistance

ANSWERS to your questions about Welded Stainless Tubing are in this file folder. Send for your free copy today, by asking for it on your company letterhead.

THE CARPENTER STEEL CO.
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Carpenter
WELDED
STAINLESS TUBING

space to each city where flights originate and clears requests for more space through this office.

Flight operations: UAL DC-3's passed 1,000,000 hr. aloft, with total air mileage at 168,438,804 mi. Figures cover period since '36 when planes were put into service by company. Planes being operated by company for Pacific ATC have reached utilization of eleven-and-a-half hours daily, flying about 42,500 mi. daily between San Francisco-Honolulu-Guam . . . AA has flown 7,000th crossing of Atlantic for ATC; in a recent month airline flew more than 1,717,000 mi. . . . REA states that company's international air express shipments, not including Canadian traffic, showed a 41.6% increase for first quarter of '45 over same period last year, with a total of 75,077 shipments handled . . . NWA carried 78,887 revenue passengers in first quarter of '45, with revenue mi. flown at 50,750,000. Increase was 100% in passengers carried over same period last year . . . Consairway div. has flown 65,000,000 ton-miles in 104,000 flight-hours in three years of Pacific operations. Average payloads have been 8,000 lb., and equipment utilization of bombers converted into transports has been 12 hr. daily.

★ CALLING NAMES ★

(*Continued from page 213*)

west coast plants; **Robert C. Harlan** was promoted to mgr. of personnel; **Wilford Canavan** was made new equipment mgr.

M. LeRoy Stoner has been appointed staff engineer, aero dept. of SAE, N. Y.

M. E. Sullivan became mgr. of rates and traffic for Western Air Lines.

J. Story Smith, vice-pres.-secy. of Jacobs Aircraft Engine Co., resigned his post.

John S. Wynne has been named legal counsel for Northeast Airlines in Washington, D. C.

Glenn L. Martin received an honorary degree of Doctor of Science from U. of Omaha.

Horace Bolding has been appointed purchasing agent for Braniff Airways.

Donald W. Doherty became traffic representative in Minneapolis office of Mid-Continent Airlines.

J. R. Yarrow resigned as airport turf engineer, airport service, CAA, to join Airways Engineering Consultants, Inc., Washington, D. C.

Alonzo Petteys, vice-pres. and director of Farmer's State Bank, Brush, Colo., has been named a director of NWA.

J. Kirk Baldwin became airport consultant to Aviation Section of N. Y. Board of Trade.

Gerhard Mauric has been made chief engineer of Electrical Engineering & Mfg. Corp., makers of electric motors and actuators for aircraft.

Anthony Burke has been appointed to direct public relations office of Hughes Aircraft Co.

Chauncey J. Lake has joined Jack & Heintz' advertising dept.

K. R. Jameson resigned his post as vice-pres. in charge of sales for Pacific Airmotive and has established firm of Jameson & Co., with offices at 6715 Hollywood Blvd., Calif.

M. J. "Marty" Johnson became mgr. of aircraft sales for Elastic Stop Nut Corp.

Murray T. Jackson has been named asst. district traffic mgr. with hq. in Miami; and Walter Pearce became airline's station mgr. of Sarasota-Bradenton, Fla.

Colonial Airlines elections: **Sigmund Janas,** pres.; **E. S. Ridley,** vice-pres.; **Branch T. Dykes,** vice-pres. in charge of operations; **Alfred M. Hudson,** vice-pres. in charge of traffic; **J. V. Flanagan,** treas.; **K. Hamilton,** secy.; and **Carl L. Anthony,** asst. secy.

Harold D. Koontz became coordinator of planning for TWA; **J. F. Ebbert** was made director of sales and service for airline's central region; and **Miss Jeanne Stanton** became traffic representative in Cincinnati.

Capt. Edward Nichols has been appointed mgr. of new municipal airport at Merced, Calif.

Rear Admiral Harold B. Sallada was nominated by Pres. Truman to be chief of Navy's Bureau of Aero, succeeding **Rear Admiral DeWitt O. Ramsey.**

IAS elections: **Rex B. Beisel, George W. Brady, William K. Ebel, Sherman M. Fairchild** and **Elmer A. Sperry, Jr.,** to council; **Walter Beech, Laurence D. Bell, Allan D. Emil, C. L. Egtvedt, R. H. Fleet, Jack Frye, R. T. Goodwin, Robert E. Gross, R. M. Hazen, J. C. Hunsaker, Th. von Karman, J. H. Kindelberger, P. W. Litchfield, F. W. Magin, Charles Marcus, Glenn L. Martin, R. C. Muir, Thomas A. Morgan, John K. Northrop, W. A. Patterson, E. T. Price, F. W. Reichelderfer, Fred H. Rohr, T. Claude Ryan, J. T. Trippe, Guy W. Vaughan, J. G. Vincent, Edward P. Warner,** and **Eugene E. Wilson** joined advisory board.

★ TAGGING THE BASES ★

Milwaukee's new 2,700 ft. flightstrip, next to Anthony Lange's seaplane base on waterfront, will be within 5 min. walk from business section. Plan was sponsored by Civic Committee on Aviation headed by **Francis J. Traecker.** Local operators E. Merritt Anderson and Merle C. Zuehlke worked on committee, says NATA *Dispatch.*

Thor Solberg, of Solberg Hunterton Airport, at Readington, N. J., is now handling surplus disposal sales for RFC and has on hand Cessnas, Fairchilds, and Vultees.

Cleveland district operators have adopted cooperative newspaper advertising with good results. Ad in *Plain Dealer* lists: Aircraft Service, Inc.; Cleveland Flying Service; Dethloff Flying Service; Frank's Flying School; Tanner Flying Service; General Airmotive Corp.; Horn's Flying School; Ideal Flying Service; Mather Airport; Aero-Ways, Inc.; Ward Airport; Melter Flying Service; Sky Haven Airport; Sky Tech, Inc; Sundorph Aeronautical Corp.; and Euclid Ave. Airport. Western Finance Co. of same city, has developed plan to finance pilot training and solo flight time.

Otto Airlines report future bookings on their Teterboro-Atlantic City route are heavier than were expected. Teterboro-Blairstown run is also busy.

Flying Farmers of Oklahoma will hold meeting at Okla. A & M college, on Aug. 2 and 3. Nearly 100 members are expected to attend, as well as airport managers from nearby states.

Agricultural Airplane Operators Assn. has been formed at Yakima, Wash. H. A. Poulin, P. O. Box 1364, is Pres.

Commando

CHOSEN STANDARD TROOP CARRIER . . .

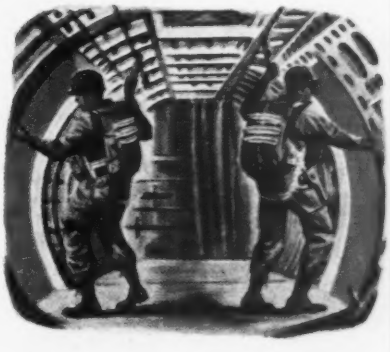
Long famed for their prodigious work as Himalayan "Hump Run" haulers, C-46 Commandos have been chosen the standard aircraft of the Troop Carrier Command. In their initial action, they precipitated paratroopers onto the German plain in the first Allied aerial crossing of the Rhine.

LONG RANGE— DOUBLE FIGHTING PUNCH

With an 1800 mile range and 36 paratrooper capacity, Commandos revolutionized airborne operations by doubling the fire and fighting power any previous American transport ever carried into action.

DOUBLE JUMP DOORS

New, double paratrooper doors on the C-46 enable simultaneous unloading from both sides of the plane. More troops can be spilled into a smaller area, can more quickly assemble in strength for strong surprise land attacks.



REPLACEMENTS BEING C-46 TRAINED

All future troop carrier replacements will be trained for C-46 Commando operations. Transition training has already been given units overseas. This world's largest and fastest twin-engine transport is destined to play a part of increasing importance in America's expanding aerial warfare.

CAN TOW GLIDERS

Its ability to tow all types of gliders from the CG-4 to the newest, largest CG-70 "Trojan Horse", plus its greater power and range make the Commando ideally practical for the longer reaches of the Pacific war theater where the C-46 is destined to see plenty of action.

CURTISS AIRPLANES
DIVISION OF
CURTISS-WRIGHT
FIRST IN FLIGHT

Printed in U. S. A.

U. S. Navy's Grumman Hellcats "On Target"

Grumman

AIRCRAFT ENGINEERING CORPORATION, Bethpage, L. I., N. Y.

★INTERNATIONAL BRIEFS★

England

Gross weight of H.P. Hermes has been upped 5,000 lb., to enable plane to carry loads ranging from 4½ to 8 tons at 191 mph. over ranges from 3,000 to 1,740 mi. With cruising speed of 240 mph. and same loads, ranges are from 1,600 to 2,700 mi. Standard version will have accommodations for 34 passengers in a pressurized cabin. A freighter model is also under development.

English contender to Douglas DC-3 is Miles M-56, mounting two Merlins, and Miles M-60, with four DH Gipsyqueen engines. Prototypes of both are expected to fly shortly.

Society of British Aircraft Constructors has decided upon an export section, headquartering in London and having branch offices internationally to which "trade ambassadors" are to be sent to promote use of British aviation products. First on list for branches are Latin America, India, Far East, Middle East, and Dominions.

RAF is testing intact examples of late German Heinkel 177 twin-tandem-engine bomber and Me-262 jet fighter. It is noted that Jumo 004 jet units are reported to use ordinary Diesel oil instead of kerosene or more volatile fuels.

BOAC, in addition to its generous subsidy, is reported to have run up losses varying from 6½ million dollars in 1941 to nearly 8 million in 1943.

Four times weekly service between England and America has been started by BOAC with Boeing 314's. These craft are later to be replaced by larger and faster Shetlands.

It is revealed that continuous bombing of Germany by RAF and AAF was enabled by British development of special fog-banning oil burners which were employed along military airport runways.

Among many new items displayed at recent air show in Paris was 42-cyl. 6-row liquid-cooled Mathis engine of 2,300 hp., prototype of a 7,350 cu.in. model reported to have developed 5,000 hp. during bench tests.

Gnome & Rhone is reported to have developed a 28-cyl. four-row engine of some 3,500 hp.

Netherlands

Internal air services are soon expected to be re-opened by KLM in addition to connections with England. It is said company will continue operations to Lisbon and will also soon make trial flights to India preliminary to reestablishment of famed London-Batavia line.

Sweden

Courier air service between Sweden and U. S. with Douglas C-54 aircraft was recently inaugurated. Route runs via Iceland and Newfoundland.

Notable cuts in fares were announced by ABA, cost of passage from Stockholm to England being reduced to a new low of 350 Crowns (approximately $80). When service was initially opened, fare was double this amount. Similar reductions have also been made on line's domestic routes.

Czechoslovakia

Czech Government was recently assigned a number of surplus Douglas DC-3 type craft from European stockpile to enable both the CLS (privately owned) and CSA (government-owned) airlines to resume their services.

USSR

Aerial services linking Moscow, Warsaw, and Berlin have been opened. Report did not mention type of aircraft used.

Australia

First North American designed P-51 Mustangs produced under license in Australia are expected to go into early action against Japs.

Sen. Nichols, of State of South Australia, is planning to conduct his election campaign with a helicopter, making speeches from hovering craft. What make of rotor craft he has in mind has not been revealed. In any event, a well-rigged public address system is respectfully suggested for pitching his voice over operational noises of his up-and-down craft.

Japan

Nipponese industry has been exhorted to develop wooden aircraft, also engines which can use substitute fuels, now that supply of metals and oil has been restricted through heavy blows of B-29's.

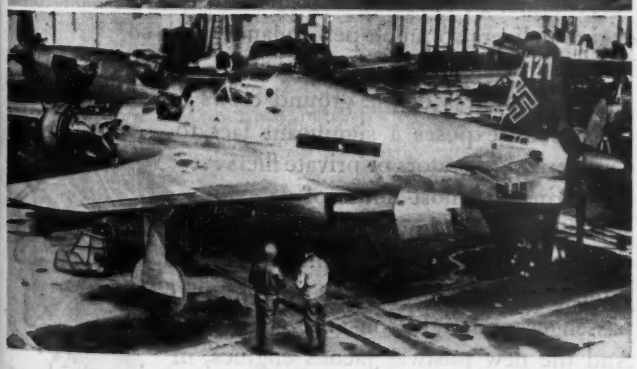
WORLDATA. . . . . By "VISTA"

In earlier issues we noted Australia's plans for complete nationalization of internal and international airlines, then told how Britain ventured the same path with its White Paper. However, the latter has since been relegated to the blueprint status. And now Australia's government likewise appears to have run into opposition, moves being underway to force a change in its viewpoint.

According to initial reports, Acting Premier Ford had blankly stated that the Australian airlines would be taken over by the government through a new agency. But then the subsequent official speech opening Parliament considered the plan in the proposal light, and attention to this marked difference is pertinent, states AVIATION's Australian correspondent. It is noted that electors twice defeated the plan, that legal action by airline operators would seriously affect postwar expansion, that even the cabinet is not in agreement, and finally that a recent committee called for a company with 50-50 interest between government and public. There is popular approval for the latter plan in view of the success of similar organizations in Australia, contrasted with the failures of a number of purely government owned companies.

A recent issue of *Aeroplane* takes us to task for shortcomings of the British data in our 1945 Directory Issue, continuing with a general blast at American publicity methods and failure to give representative credit to British developments. We might say here that lack of space has a pertinent bearing on such coverage, together with the fact that the Directory is primarily for domestic consumption, thus calling for deserved accent on the national product. Specifically, however, we hasten to point out that neither precise nor comprehensive information has been available from either the British Air Ministry or English propaganda sources. Seldom, it appears, are British manufacturers allowed to release official specifications. Accordingly, most information received here is either second or third hand, with all that implies. We can hardly present the proper details until the Britons contrive to cut their censor-ganda knot of Gordius—which, it is quite evident, was just what the *Aeroplane* was trying to do by taking a blast at us.

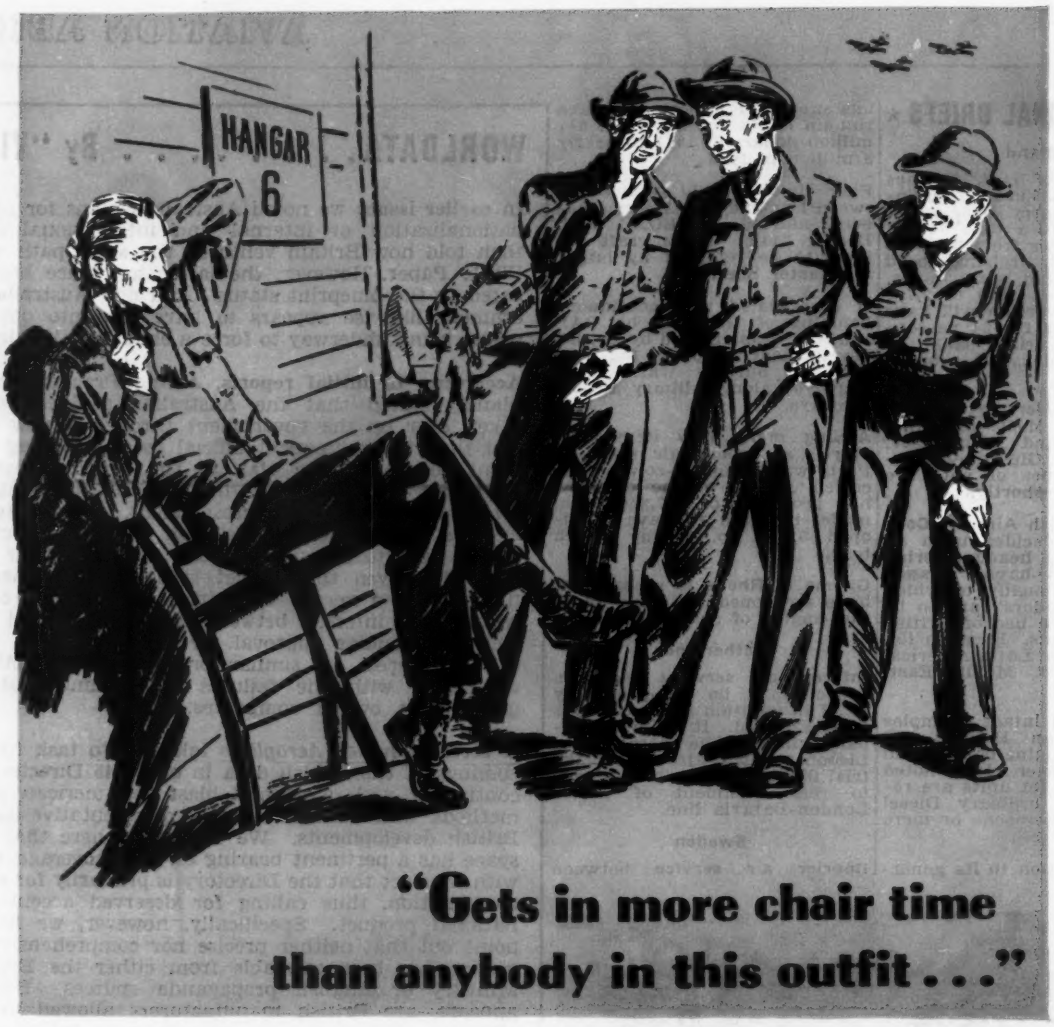
It appears now that British pressure to prevent American aircraft being sold to Commonwealth nations for commercial purposes, thus protecting British industry, has been extended to both Egypt and South Africa. The latter, it's reported, have been informed that their sterling balances would be blocked if they attempted to use them for purchase of American craft.



TOO LITTLE—TOO LATE

. . . for Nazis to get any use out of 'em. That's the epilogue on these late-model German fighter-bombers captured by U. S. Army units in last days of European war. In foreground of top photo is seen an Arado Ar-234 jet plane which saw action in only small numbers near war's end. Powered by two jet units, one beneath each wing, craft has retractable tricycle landing gear. Note (background) Junkers Ju-88 night-fighter-bombers with radar "feelers" fitted just ahead of cockpit. (British Combine photo)

Dornier Do-335 (above) is tandem-engine craft with props at nose and tail. Plane seats at least two, has retractable tricycle landing gear, and its rudders extend both above and below fuselage. There has been no mention of this craft in action, so presumably it never got into mass-production. Top speed was above 400 mph. at 25,000 ft. (Acme photo)



"Gets in more chair time than anybody in this outfit . . ."

"Surely not Staff Sergeant Hotshot, the big executive engine expert?"

"A livin' lie! The Old Man thinks it's efficiency."

"Tch tch! Don't the CO know all you gotta do is speak kindly to them Jacobs engines and they run forever?"

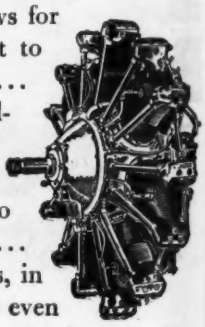
"Sorry, crumbs," said the S/Sgt. "But a good engine deserves a good man."

AT the bomber training fields, ground crews working on Jacobs engines took a lot of ribbing —because they had less work to do.

The Jacobs is no glamour job, to be tuned, teased and toleranced for a few hours of flashy performance. It's a tough baby, first built for tough pilots who made their living by flying and tending their own planes.

The Jacobs had a tough war assignment—hauling around twin-engine training planes . . . flown by students, taking more take-offs and time at full throttle than plane engines in any other kind of service.

Expected to deliver 350 flight hours between major overhauls, the service period of the Jacobs was extended again and again—to as much as 1,200 hours. To our knowledge, no other plane engine delivers so much performance, with so little maintenance.



The fondness of the ground crews for the Jacobs exposes a significant fact to commercial operators or private fliers . . . Delivering the most hours of dependable power at the lowest maintenance expense, the Jacobs can put more profit into scheduled operation, into passenger or freight ton-mile costs! . . . And the new postwar Jacobs engines, in both large and small units, will be even better performers! Inquiries invited . . . Jacobs Aircraft Engine Co., Pottstown, Pa.

JACOBS · **Pottstown, Pa.**

Jacobs Aircraft Engine stock control has changed hands through the sale of majority holdings (59 percent) to Continental Engineering & Management Corp. Continental firm (which has no connection with Continental Motors, Inc.) also offered for a limited time to buy holdings of other stockholders at $6 a share. Chairman J. A. Harris of Jacobs said the move was made to widen financial and manufacturing scope of his company.

Bell Aircraft reported unfilled orders of $500,000,000 on Mar. 31. Since then contracts for company's P-63 fighter have been cancelled, but larger B-29 bomber orders remain. Bell also reported 1944 net profits of $3,156,975 or $9.53 a share against 1943 profits of $2,462,414 or $7.77 a share. Sales were $317,473,879 against $232,134,628 in 1943. Current assets totaled $87,746,000 compared with current liabilities of $77,843,000.

Bendix Helicopter, Inc., has sold 1,000,000 shares of capital stock at $2 a share. Proceeds will be used to acquire additional facilities and personnel for continued research and development and for construction of flying production models of helicopters.

Dividends: Recent dividend payments included **Breeze** Corp., 40¢ a share; Air Associates, 20¢; Braniff Airways, 15¢; Continental Motors, 20¢; Delta Air Lines, 50¢ annual dividend; and Glenn L. Martin, $1.50. All above payments were the same as previously disbursed.

Dividend Changes: United Aircraft Corp. paid a $1 common dividend on June 15 compared with dividends of $1.50 a share in June and December of 1944. . . . Grumman paid a $1.50 dividend on May 24 compared with dividends of $1 in May and of 50¢ in November of 1944. . . . Ryan Aeronautical recently paid a special dividend of 15¢ a share, which Pres. T. Claude Ryan said was justified from 1944 profits.

American Airlines reports March quarter net profits of $980,642 or 76¢ a share against net profits of $597,796 or 95¢ in the like 1944 quarter. Operating revenues were $9,951,769 against the sum of $7,454,864 a year ago.

Bellanca Aircraft Corp. reports 1944 sales of $6,652,982 compared with $6,122,492 in previous year. Net profits were $291,862 or $1.27 a share compared with net profits of $332,227 or $1.44 a share in 1943. A contingency reserve of $220,000 was set aside from 1944 earnings.

United Air Lines reports first quarter net income of $1,643,288, equal to $1.02 a common share, compared with net income of $1,110,083 or 66¢ a share in the like 1944 period. First quarter operating revenues were $9,392,593 against the total of $7,235,615 recorded a year ago.

Square D Co. reports first quarter net income of $446,376 or $1.01 a share compared with net income of $498,433 or $1.13 a share in the like 1944 period. First quarter profits are figured after a reserve for renegotiation based on past experience, according to Pres. F. W. Magin.

National Airlines stockholders have approved an increase in capital stock from 500,000 shares to 1,000,000 shares. Approval also was given to company's acquisition of Caribbean Atlantic Airlines, Inc., a line operating in Puerto Rico and Virgin Islands.

Eastern Air Lines reports March quarter profits of $446,091 or 76¢ a share compared with net profits of $178,520 or 30¢ a share in like 1944 quarter. Operating revenues were $5,872,929 in 1945 quarter; those for like 1944 period are not available.

Transcontinental & Western Air reports March quarter net profits of $504,008 or 52¢ a share compared with a deficit of $102,403 in like 1944 period. Operating revenues were $7,141,461 against $4,449,122 in Mar. 1944 quarter.

Pennsylvania-Central Airlines reports March quarter net income of $71,128 or 15¢ a share compared with a net loss of $52,516 in like 1944 quarter. Operating revenues were $1,991,667 against $928,686 in Mar. 1944 quarter.

Northwest Airlines may move its headquarters from Minnesota unless personal property tax situation there is remedied, according to company officials. March quarter net profits of Northwest were $77,846 or 22¢ a share against net profits of $37,742 or 16¢ a share in same quarter of year 1944.

Braniff Airways reports March quarter net income of $105,436 or 10¢ a share against net profit of $98,995 or 18¢ a share in same 1944 quarter. Operating revenues were $1,623,828 against $1,124,195 in like 1944 period.

Western Air Lines reports March quarter net income of $117,607 or 29¢ a share compared with a net loss of $17,564 in corresponding 1944 period.

National Aviation Corp. reports net assets per share of $19.60 on Mar. 31 against net assets of $16.42 a share on the like 1944 date. Net income for March quarter was $22,544 against $23,913 a year ago, while market value of investments held were $7,832,231 on Mar. 31 against $6,59,618 a year ago.

ADDING IT UP.....By RAY HOADLEY

Profit Outlook. As had been expected, the recently announced aircraft cutbacks will reduce both 1944 gross business and net profits for the companies affected. However the executives of some of those hardest hit so far by cancellations privately assert that the cutbacks are not entirely unwelcome, since they will permit a more orderly reconversion than if all contracts were suddenly cancelled and will enable them to put more emphasis on preparation for postwar operations.

Financial Position. Certainly almost all companies are in a better position today to go through reconversion than they were a year ago. Take the case of Consolidated Vultee which appeared to be definitely affected by the flock of cancellations occurring last month. At the end of its 1944 fiscal year this company had $35 a share in net current resources, including rebates on excess profits tax and the value of unamortized emergency facilities. Then, too, the company may be presumed to have accumulated substantial profits on the large deliveries made so far this year.

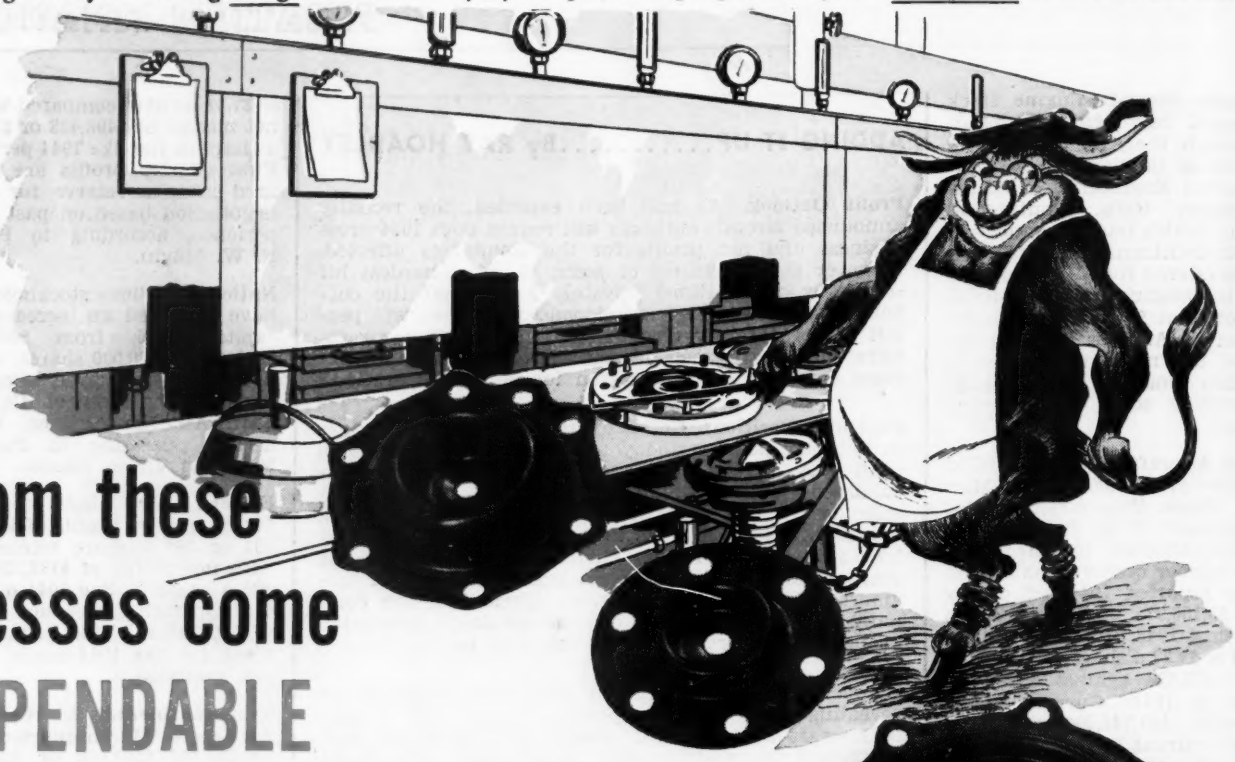
Competition. The automotive companies gradually are revealing their probable postwar stand with respect to aircraft manufacture. Studebaker executives have reaffirmed the position they have taken right along. With the cancellation of Studebaker's big contract to make Wright engines the company is turning toward resumption of automobile production and has no interest in the immediate postwar civilian aviation market. On the other hand, Packard will keep the door slightly ajar through an experimental and research assignment on aircraft engines for the government.

Airline Earnings. First quarter operations of the domestic airlines resulted in almost phenomenal gains in earnings despite the traditional poor weather in that three months period. Eastern Air Lines' profits gained 50% over a year ago, TWA reported net of $504,000 against a deficit in the like 1944 period, and Pennsylvania-Central turned a Mar. 1944 loss of $77,000 into a profit of $169,000 in the first 1945 quarter. And so it went through the industry.

Airlines Outlook. But despite the excellent first quarter showing, airline executives maintain that accurate estimates of earnings for 1945 are impossible—at least for the larger lines—until the matter of airmail rates is disposed of. The retroactive feature of the CAB proposal that mail rates be reduced from 60¢ a ton-mile to 32¢ might seriously effect the profits of those big lines which have been requested to show cause why the rate reductions should not be made. Everyone is still wondering how much weight the CAB will give to the passenger fare cuts, averaging more than 10%, which most lines already have put into effect.

Mid-Continent Expansion. Pres. J. W. Miller of Mid-Continent Airlines, speaking at the annual stockholders meeting, gave a graphic example of the current progress his organization is making. Revenue of Mid-Continent has been increasing more than 30% a year or, in other terms, has doubled nearly every 2½ yr. since 1936. In 1944 the company's revenue jumped more than 70% from 1943, with 74,000 passengers carried, or almost twice the number using the service in 1943.

Man's genius for making things is limited only by the physical properties of the substances used to make them.



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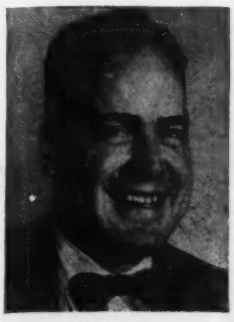


A. T. HAPKE, JR., has joined staff of American Petroleum Industries Committee of American Petroleum Institute, and will head newly created aviation section. Prior to this post, he had been market research manager for Republic Aviation. He is also a member of QB and Wings Club.

CAPT. EDMOND KELLY has returned to presidency of Aviation Equipment Sales Corp., Los Angeles, after three yr. in AAF. While in service he was stationed in production engineering div. at Wright Field. He volunteered for glider training and was later transferred to Materiel Command.

WELLWOOD E. BEALL has been elected to Boeing's board of directors. Now vice-pres. in charge of engineering, he joined company in 1930. He was instructor in company's aero school, then successively became sales manager, chief engineer, and attained present post in '43.

REED M. CHAMBERS was elected pres. of Wings Club. He served in World War I with first American pursuit squadron to reach front. He became one of ranking U. S. aces and commanding officer of famed 94th pursuit squadron. He is also pres. of U. S. Aviation Underwriters, Inc.

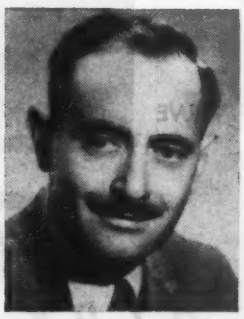
JOHN C. HARROWER has been elected vice-pres. in charge of sales and engineering for Air Associates. His previous position was sales mgr. for Eclipse Aviation, and prior to that he had been production mgr. with Bendix Aviation. He has served as communications engineer for NAT.

JOHN J. HOSPERS (left) has been made sales mgr. for United Aircraft Corp. He formerly was field service mgr. for airplanes. Joining company in 1928, he served as field service mechanic, flight test observer and project man on experimental airplanes. In 1942 he joined United Aircraft Service Corp. **WILLIAM H. McCARTHY,** formerly company asst. field service mgr. is new field service mgr. With United Aircraft for 13 yr., he was with Sikorsky div. working on S-42, S-43 and XPBS-1 and was asst. chief inspector of final assembly and flight test for Vought-Sikorsky when he joined United Aircraft Service Corp. in '42.

ERIC JOHNSTON has been elected a director of UAL. Pres. of Chamber of Commerce since 1942, he is also pres. of Brown-Johnston, Columbia Electric Co., and Washington Brick & Lime Co., all of Spokane. He is a member of State Department's Economic Policy Committee. (UAL photo)

MAJ. EDWARD M. STURHAHN (left) has been appointed exec. asst. to CAA Administrator T. P. Wright. Maj. Sturhahn had been released from Aircraft Scheduling Unit of AAF to assume his new duties. In 1929 he was pres. and gen. mgr. of Dixie Flying Service, then became EAL's purchasing agent. **ROBERT W. CRAIG** has been named liaison officer between CAA and U. S. Weather Bureau, a newly created office for purpose of improving international weather forecasting and reporting. He is to be CAA's consultant on all weather problems and will assist in plans for extension of airways weather stations. (CAA photos)

C. HART MILLER has been appointed exec. vice-pres. and general mgr. of Republic Aviation. He is also vice-pres. and Farmingdale div. mgr. of company. Joining company in 1935 in an engineering capacity, he became test pilot, chief pilot, engineering asst. to pres., asst. to pres. In 1940 he was director of contracts.

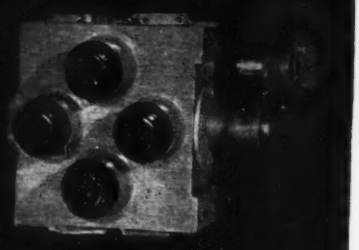


VICTOR E. SEMRAU has been appointed secy.-treas. and controller of Pacific Airmotive Corp. His first position with aviation industry was with Aero Corp. of Calif. In 1930, followed by two yr. with Catalina Air Lines. Eleven yr. ago he joined Kinner Motors and became secy.-treas.-controller.

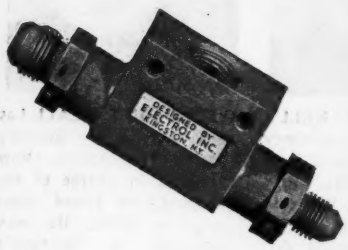
R. L. PROCTOR was appointed chief flight engineer for TWA's domestic routes and will be in charge of company's flight engineers assigned to Boeing Stratoliners as well as TWA's new flight engineer school. He had been asst. chief flight engineer on airline's intercontinental division flying Atlantic.

JULIA M. SCANLON (left) has been elected secretary of C-W Corp. and its subsidiaries. Her new position is considered one of most responsible held by any woman exec. in industry. Joining Wright Aero in 1928, she has been asst. secretary of C-W and Wright, also asst. secretary of L. G. S. Spring Clutch, and secretary-treas. of AWPC, East Coast, Inc. **R. J. LINDQUIST,** vice-pres.-controller, is new treas. in move to combine duties of these offices. He joined corp. and was made a vice-pres. in charge of finances in 1943, after having served as vice-pres. and director of Reynolds Metals Co. since 1941. He graduated from University of Illinois with B.S. degree and as a C.P.A.

DEPENDABILITY

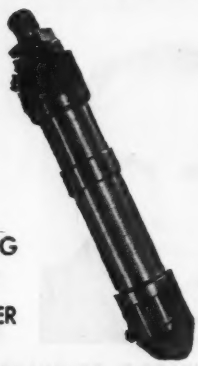


SELECTOR VALVE



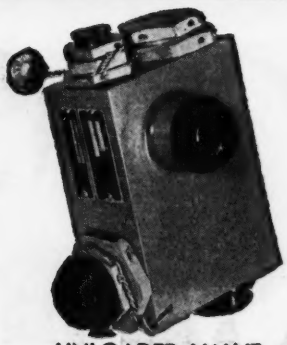
SHUTTLE VALVE

HAND PUMP

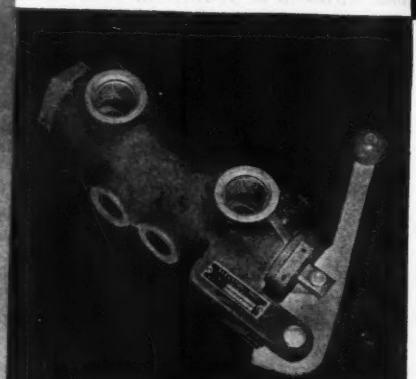


LANDING GEAR CYLINDER

CHECK VALVE

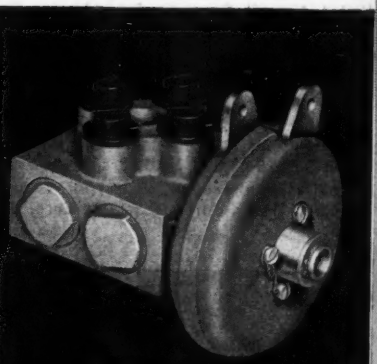


UNLOADER VALVE



SLIDE SELECTOR VALVE

MAIN PRESSURE RELIEF VALVE



FOLLOW-UP VALVE

ELECTROL HYDRAULICS

ELECTROL INCORPORATED, KINGSTON, NEW YOR

REVIEW OF PATENTS

By A. HARRY CROWELL *Registered Patent Lawyer*

FOLLOWING are digests of some of the more interesting recent patents on aviation developments granted by the U. S. Patent Office. Mr. Crowell will gladly furnish readers with free information on approximate cost and procedure in applying for patents and trademark registration. Address inquiries to him, care AVIATION, 330 W. 42nd St., New York City (18). Printed copies of any patents listed are obtainable at a cost of 10c. each, directly from U. S. Patent Office, Washington.

Stall Delaying and Indicating Mechanism embodies series of tabs located at various points on airfoil, with each tab connected in parallel in single electrical circuit, so that when any tab is actuated by stalling turbulence or reversal of flow, indicator is energized. Slot closures, normally in closed position, are moved to open position upon rising of tab, and act to automatically delay or quell stall.—2,373,089, filed Nov. 2, '40, pat. Apr. 10, '45, E. T. Allen and R. J. Minshall, assignors to Boeing Aircraft Co.

Landing Gear, mechanically operated, intended to provide lightweight installation and positive action, includes retracting arm, gear locking lever, and resilient means connected to said lever for urging it into interlocking engagement with gear retracting arm in either extended or retracted position. An unlocking beam is pivoted on gear retracting arm and is swingable into camming engagement with locking lever to move it out of interlocking engament with gear retracting arm.—2,373,137, filed Apr. 8, '43, pat. Apr. 10, '45, C. J. Morgan.

Automatic Pilot to control rudder for azimuth steering incorporates auxiliary control element operative on pickoff from rate gyroscope and introduces follow-up means for pickoff, which is out of phase with primary impulse, by an amount roughly proportional to rate of precession of rate gyroscope. No oil throttle, special valves, or pressure reducing bypass valve in the oil lines are required, amount of rudder throw being regulated by several air valves.—2,373,315, filed May 22, '40, pat. Apr. 10, '45, T. W. Kenyon, assignor to Sperry Gyroscope Co.

Wing Flap Supporting and Operating Means is designed for air load acting on underside of flap to counteract action of flap power drive so that (at airspeeds at which deflected flaps lose their lift effectiveness, and upset airflow over fixed portion of wing, and also unduly increase the drag) this air load will overcome action of drive and positively prevent flap deflection or automatically effect retraction.—2,373,365, filed Dec. 19, '41, pat. Apr. 10, '45, A. H. Westberg, assignor to Republic Aviation Corp.

Flap Transmission Mechanism is designed to move flap slot-shutter to open position upon initial extending movement of flap, positively locking shutter in open position throughout further extension, and finally returning shutter to slot-closing position as flap is raised.—2,373,542, filed Sept. 26, '41, pat. Apr. 10, '45, J. R. Clark, assignor to The Glenn L. Martin Co.

Pilot-Training Equipment for teaching rudder manipulation during ground operation includes cockpit of typical trainer fitted with stick, throttle lever, rudder pedals, and units operated to cause turning, together with means whereby instructor may influence turning of cab to different directions so that student may practice rudder action necessary to overcome outside effects which resemble cross-winds or other conditions apt to be encountered.—2,373,653, filed Mar. 1, '43, pat. Apr. 17, '45, T. C. Barber.

Auxiliary Bomb Rack Adapter, arranged chordwise under wing bottom and having capacity materially greater than usual bomb rack, is designed for operative association with latter so that bombs carried by adapter may be discharged singly or in salvo, with mode of operation being effected by mechanism of conventional rack.—2,373,904, filed Oct. 10, '40, pat. Apr. 17, '45, C. H. Miller and C. H. A. Hartley, assignors to Republic Aviation Corp.

Anti-Icing System for wings is designed to prevent overheating by use of additional air ram located on leading edge, and preferably in propeller slipstream, to cause considerable volume of cold air to mix with hot air passing through wing edge conduit and so reduce temperature of heated air to degree at which no damage to wing can result. Mixing of cold and heated air is continuous and automatic.—2,373,728, filed Mar. 31, '44, pat. Apr. 17, '45, E. D. White.

Mixture Control for Aircraft Heaters, designed to regulate degree of richness, employs heat exchanger for cooling mixture withdrawn from carburetor and for condensing an appreciable portion of vaporized fuel contained in mixture. Included is separator to divide condensed fuel from mixture, together with means for adding liquid fuel to mixture at rate dependent on level of liquid in separator.—2,374,606, filed Mar. 7, '42, pat. Apr. 24, '45, H. J. De N. McCollum.

Jig for Large Aircraft, employed in assembling fuselage side panels to intermediate transverse floor member, is de-

(*Continued on page 277*)

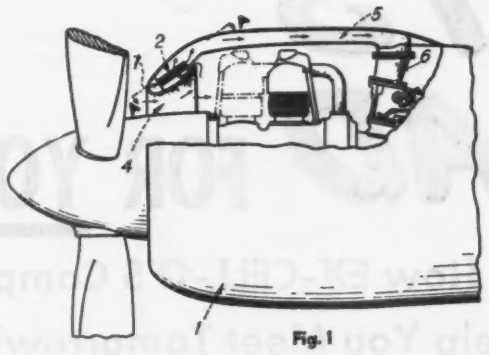


Fig. 1

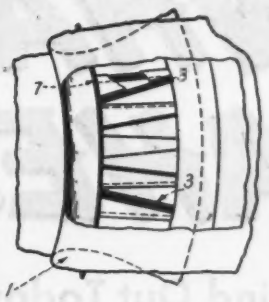


Fig. 2-View along A-A, Fig. 1.

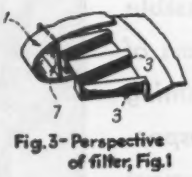


Fig. 3-Perspective of filter, Fig. 1

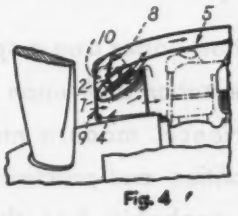


Fig. 4

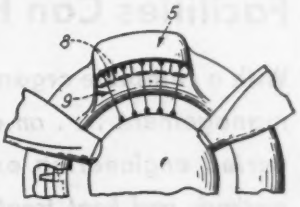


Fig. 5-Front elevation, Fig. 4

Air Filter in form of annulus within cowl provides large area of screening material for passing air to conduit leading to carburetor intake, so that maximum volume may be filtered without appreciably reducing pressure. Manually operated gate provides for optional admission of air directly to conduit from outside of cowl without passing through filter. As seen in accompanying Figs. 1, 2, and 3, at forward end of cowl (1) and entirely housed within its periphery, is annular filter (2) having plurality of screens (3) angularly disposed to each other to increase total screening surface. Admission of air to filter is via cowl central opening (4), and after passing screens, air enters conduit (5) leading to carburetor intake (6). Forward end of conduit (5) extends around periphery of cowl and radially outward of filter screens. Front wall (7) closes end of filter and constrains air to pass through screening material. In embodiment of invention shown in Fig. 4 and 5, plurality of spring-hinged gates (8) provided just above upper portions of annular filter (2) and adjacent to front end of conduit (5) are manually operative from cockpit by cables (9). In normal, open position, gate is held by spring hinge against outer wall of filter and air is admitted directly to intake conduit (5) from opening (10) in cowl without passing through the filter.—2,374,412, pat. Apr. 24, '45. F. Caldwell, assignor to United Aircraft.

Book Reviews

HIGH JOURNEY, by Carleton Putnam. Chas. Scribner's Sons, N. Y. C. 301 pages, maps, index. $2.75.
Most interesting story of author's student flying in Arizona back in Curtiss Robin days, and how his aerial study of Western history led to the formation of Pacific Seaboard Air Lines, which was later developed—missing failure by a hair—into today's Chicago & Southern system. An extremely readable combination of reminiscence, philosophy, and the type of American business story that needs telling.

JUSTICE IN TRANSPORTATION, by Arne C. Wiprud. Ziff-Davis Pub. Co., Chicago. 197 pages. $2.50.
Considered here is monopoly control in transportation and its phases, and included is a section on future transportation. Foreword is by Thurman Arnold.

THE COMING AGE OF ROCKET POWER, by G. Edward Pendray. Harper & Brothers, N. Y. C. 244 pages, text, illustrations. $3.50.
Traces evolution of the rocket principle

(*Continued on page 274*)

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Above: Sectional view of Ex-Cell-O precision boring department for miscellaneous production parts.

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SIDE SLIPS

NOW THAT A FEW of the industry's slipstick artists might be able to find a minute or so to raise their heads from formulas, leave us start a little internecine warfare just to keep things normal.

A wag has just written in to define an aeronautical engineer as "a person who passes as an exacting expert on the basis of being able to turn out with prolific fortitude infinite strings of incomprehensible formulas calculated with micromatic precision from vague assumptions which are based on debatable figures taken from inconclusive experiments carried out with instruments of doubtful reliability and questionable mentality for the avowed purpose of annoying and confounding a hopelessly commercial group of fanatics referred to altogether too frequently as airplane designers."

Okay, engineers, the typewriter and dictionary are yours—but just keep it clean.

• Pilots of two different fighter types were arguing the relative merits of their ships, as pilots *have* been known to do. The argument ended abruptly when one 'em snorted, "Man, our ships are so fast that we just follow our own vapor trails back to base."

• "They laughed," said Rosie the Riveter, "first time I wore my slacks, but when I sat down they split."

• Guess the Boeing B-29's will have to be given a fighter designation too, judging from what the boys are doing with them. Other day, for example, two of the last ones away from the target saw a third going down fairly close to the coast of Japan. Seeing the crew bail out they signalled for a rescue party, knowing it wouldn't be long arriving. But just as they were starting on back to base, they saw five Jap fishing boats heading for the parachuting crew. As if that wasn't enough, six Jap fighter planes dove out of the clouds. Calmly, one B-29 pilot radio'd the other, "You take the planes, I'll take the boats." So, like he was flying a single engine fighter, he hit the deck and the Japs—got four out of the five—while his compadre stayed upstairs, also making like a fighter pilot.

So help us, he got five out of the six planes, by which time the downed crew had been picked up.

• Enroute to his native state of Texas the pilot—a swell ATC Captain—made no attempt to hide the fact he was glad to be going "home" even for a couple of days. Consequently he took plenty of ribbing from his passengers, all of whom agreed he was as swell a gent as he was a pilot, partly because he really took the kidding which went on till they took off on the return trip. He'd leveled off above the overcast and the 19 hangovers had settled back to feel sorry for themselves, when suddenly the cockpit door opened and the Captain shouted, "Gentlemen, may I have your attention please! Will you all stand up—in the aisle if possible, otherwise right in front of your seats. The crisply added order "everybody up now" brought the 19 bewildered and slightly apprehensive headaches to their feet, whereupon the Captain announced seriously, "We will now observe two minutes of reverent silence as we leave the great state of Texas."

He got the door shut just in time.

• Airplanes may get obsolete, but we're about convinced they never really die. A correspondent in Australia writes that the old trimotor Fokker, Southern Cross, made famous by the late Sir Charles Kingsford-Smith and Charles Ulmn, has been fully reconditioned by the Royal Australian Air Force." It's not going to war, though—it'll be used in a movie based on Sir Charles' life.

"Maguire thinks he's going to be a millionaire with that expandable airpark to fit any community."

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3. **J-M Rock Wool Insulation.** An "investment that pays for itself" in year-round comfort, fuel economy and added fire protection. Easily installed under roof areas and in building sidewalls.
4. **Transite Movable Walls.** Build with an eye to future expansion with these modern asbestos-cement office partitions. Sturdy and durable as a fixed wall, they can be erected practically overnight, taken down and re-located just as easily.
5. **J-M Asphalt Tile Flooring.** Inexpensive, attractive, resilient . . . withstands years of constant traffic with no upkeep except cleaning.
6. **J-M Acoustical Materials.** A "must" in every modern airport! Pioneers in this field, J-M has developed materials that effectively "soak up" disturbing noise—in the office, the control tower, wherever quiet is essential.
7. **J-M Asbestos Flexboard.** Save on interior and exterior walls with this versatile asbestos-cement building board. Fireproof and rotproof, yet can be worked with ordinary carpenter's tools.
8. **Transite Ducts.** Dependable asbestos-cement protection for underground electric cables. Fireproof, rustproof, rotproof, immune to electrolytic action.
9. **Transite Pressure Pipe.** This lightweight, easy-to-handle asbestos-cement pipe keeps installation costs low, assures efficient water transportation over the years.
10. **Transite Sewer Pipe.** Companion product to Transite Pressure Pipe, designed especially for sewage disposal lines. Strong and durable, yet light in weight and economical to install.

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ENGINEERING DATA

Universal Joints 1

Folder from Curtis Universal Joint Co., Springfield, Mass., describes joint devices and provides engineering data, including illustrations, of templates for draftsmen and engineers.—AVIATION, July, '45.

Wood Products Development 2

Wood and its by-products and derivatives are discussed for benefit of engineers and executives in brochure from Timber Engineering Co., Washington, D. C. Title is *The Forest Industries Blaze New Trails.* —AVIATION, July, '45.

Stainless Steel Fasteners 3

Allmetal Screw Products Co., New York City, has issued new engineering catalog on non-corrosive fastening devices, from stock and to order.—AVIATION, July, '45.

Selenium Rectifiers 4

Manual for design engineers (Bulletin RDP-107) on selinium rectifiers is offered by Fansteel Metallurgical Corp., Chicago. —AVIATION, July, '45.

Glass Fabric and Insulation..... 5

Facts About Fiberglas for Design Engineers, booklet from Owens-Corning Fiberglas Corp., Toledo, describes uses of product, including insulation of aircraft compartments and ducts.—AVIATION, July, '45.

Actuators and Controls 6

Lear, Inc., Piqua, Ohio, has issued large loose-leaf manual, *Electro-Mechanical Aircraft Accessories,* describing each item in its various lines of actuators, controls, power units, and accessories, together with specifications and engineering data.—AVIATION, July, '45.

PRODUCTION

Rubber Adhesives 7

Booklet from B. F. Goodrich Co., Akron, lists general applications for rubber cements, includes designation of adhesives recommended, describes synthetic cements for synthetic rubber products, and gives directions for application.—AVIATION, July, '45.

Coated Abrasives 8

Comparative information on "Durabonded" coated abrasives is contained in circular from Behr-Manning Corp., Div. Norton Co., Troy, N. Y.—AVIATION, July, '45.

High Solids Lacquers 9

Listing factors in development of new high solids lacquers, *Big News in Lacquers,* leaflet from Hercules Powder Co., Wilmington, Del., considers advantages of product. A short history of lacquer is included.—AVIATION, July, '45.

Metal-Cleaning Agent 10

"Troxide", new pickling agent for removing rust, scale, and tarnish from metals, is covered in information from Waverly Petroleum Products Co., Philadelphia.—AVIATION, July, '45.

Fastener Publication 11

Containing articles on stresses, physical properties, and cold heading, Vol. 2 No. 1 of *Fasteners,* technical periodical of American Bolt, Nut & Rivet Manufacturers, Cleveland, gives table on tension, shear, and bearing values for common bolts and rivets.—AVIATION, July, '45.

Degreasing Materials 12

"Klem Kleaners", materials for rust removal, degreasing, and pickling, are described in circular from Klem Chemical Works, Detroit,—AVIATION, July, '45.

Machining Manual 13

The Machining of Ampco Metal is title of Bulletin 66 from Ampco Metal, Milwaukee, which treats on various phases of machining, gives table of recommended lathe feeds and speeds, and discusses tool design and inspection.—AVIATION, July, '45.

Transparent Tape 14

Applied as gasketing material, in construction of aircraft lighting and ignition harnesses, and used for protection of wiring and cables, transparent "Fibron" tape is described in literature from Irvington Varnish & Insulator Co., Irvington, N. J.—AVIATION, July, '45.

Blind Rivets 15

Operating principles of company's blind rivets, is explained in new manual from Huck Mfg. Co., Detroit.—AVIATION, July, '45.

Alloying Agent 16

Cerium Metals Corp., N.Y.C., offers bibliographies on cerium as alloy agent with aluminum and magnesium.—AVIATION, July, '45.

Nickel Plating Process 17

Company's bright nickel plating process, also equipment and technical service, are described in booklet from Udylite Corp., Detroit.—AVIATION, July, '45.

Fastenings Catalog 18

New catalog and manual on self-tapping screws, socket screws, and other fasteners, has been issued by Parker-Kalon Corp., New York City.—AVIATION, July, '45.

Rubber Engine Mountings 19

Containing simplified formula for calculating proper mounting for any given load, Bulletin BU-23 from Bushings, Inc., Berkley, Mich., offers dimension drawings of four typical rubber-insulated engine mountings.—AVIATION, July, '45.

Metal Balls 20

Types and specifications of metal balls made by Strom Steel Ball Co., Cicero, Ill., are contained in circular.—AVIATION, July, '45.

Spray Booth Paint Removal..... 21

Booklet from Boothcoat Div., Harris Soap Co., Buffalo, illustrates simplicity of process for removal of paint from walls and other parts of spray booths.—AVIATION, July, '45.

AVIATION READER'S SERVICE

JULY 1945

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Rotating Seal **22**

Information is available on "Spring-life Gyro Seal", new type rotating seal made by Technographics, Inc., Chicago.—AVIATION, July, '45.

MACHINERY & ACCESSORIES

Portable Storage Rooms **23**

Information on portable rooms for storage of food, supplies, tools, and other equipment, is available from Drinkwater, Inc., Chicago.—AVIATION, July, '45.

Air Cylinders **24**

Gerotor May Corp., Logansport, Ind., offers literature on double-acting non-rotating air cylinders, designed without tie rods, for 150-lb. air and 300-lb. water service.—AVIATION, July, '45.

Elevating Ladder Tower **25**

Bulletins from Universal Fittings & Scaffolding Co., Zellenople, Pa., describe new low-cost "Multi-Purpose" elevating-ladder tower designed for various airport work and plane servicing. Tower, which is elevated and extended by single hand-operated winch, has 360-deg. turning radius with variable inclination from 45 to 75 deg.—AVIATION, July, '45.

Brush-Backed Sanding Wheel **26**

Circular from Exactone Tool & Die Co., Hollywood, Calif., describes "Sand-O-Flex", brush-backed sanding wheel, used for sanding, deburring, finishing, and polishing irregular surfaces.—AVIATION, July, '45.

Adjustable Hole Cutter **27**

Pamphlet from Bruno Tools, Beverly Hills, Calif., gives details of new type expansive bit for hand brace cutting of holes in wood.—AVIATION, July, '45.

History of Abrasives **28**

Booklet from Carborundum Co., Niagara Falls, N. Y., presents history and development of company and of carborundum products, including abrasives and refractories, etc.—AVIATION, July, '45.

Extrusion Presses **29**

Schloemann Engineering Corp., Pittsburgh, Pa., offers circular on extrusion presses for production of tubular products, rods, bars, and all types of sections, strip, and wire rods.—AVIATION, July, '45.

Fuel Handling Equipment **30**

Flotrol Systems, New York City, announces Bulletin FL-100-45, *Flotrol Systems, Inc., For Clean, Dry, Safe Fuels*; and Bulletin EX-100-45, *The Lewis EXCEL-SO Water Separator and Filter.*—AVIATION, July, '45.

Industrial X-Ray Units **31**

Used for spotweld control, micro-radiography, and materials inspection, industrial X-ray units made by Picker X-Ray Corp., New York City, are described in bulletin.—AVIATION, July, '45.

Grouting Method **32**

Non-shrink method of grouting, described as providing quick hardening, ductile, oilproof and waterproof grouts, is topic of folder from Master Builders Co., Cleveland.—AVIATION, July, '45.

Coolant Separators **33**

Magnetic-automatic coolant chip separators for honing and grinding machines, manufactured by Barnes Drill Co., Rockford, Ill., are detailed in circular.—AVIATION, July, '45.

Cutting Tools **34**

Chicago-Latrobe Twist Drill Works, Chicago, offers circular titled *Cutting Tools for Efficient Operations*, which lists and describes drills, reamers, and countersinks, and makes suggestions for their use.—AVIATION, July, '45.

Carbide Machine Centers **35**

Line of carbide-tipped machine centers, made by Tungsten Carbide Tool Co., Detroit, is listed in company's Bulletin No. 127.—AVIATION, July, '45.

Chain Belts **36**

Z-Metal chain belts and their application is topic of Bulletin No. 460 from Chain Belt Co., Milwaukee.—AVIATION, July, '45.

Tool Bit Selection **37**

Folder on proper selection and use of tool bits is available from Carpenter Steel Co., Reading, Pa.—AVIATION, July, '45.

Wire Rope and Chain Fittings..... **38**

New catalog from Thomas Laughlin Co., Portland, Me., describes full line of drop forged wire rope and chain fittings, also contains charts and engineering data, such as dimensions of hoist hooks, comparative rope strength, and other information.—AVIATION, July, '45.

Dual-Ram Broaching Machine..... **39**

Designed for surface broaching, improved line of dual-ram machines is treated in Bulletin VAD-44 from Colonial Broach Co., Detroit.—AVIATION, July, '45.

Truck Running Gear **40**

Industrial truck standardized running gear, from which several types of trucks can be fashioned, is subject of Bulletin No. 1002MH, from Materials Handling Div., Market Forge Co., Everett, Mass.—AVIATION, July, '45.

Portable Lubrication Units **41**

"Lubrikarts", lubrication dispensing units in portable form, are illustrated in circular from Alemite Div., Stewart-Warner, Chicago.—AVIATION, July, '45.

Carbide Tool Grinder..... **42**

Improved carbide tool grinder is described in Bulletin No. 322 from Baldor Electric Co., St. Louis.—AVIATION, July, '45.

Use of Reciprocating Tools..... **43**

The Art of Generating With a Reciprocating Tool, booklet from Fellows Gear Shaper Co., Springfield, Vt., is termed a basic treatise on art of generating, as performed by a reciprocating tool, with variations made possible by different combinations of rotative and transverse move-

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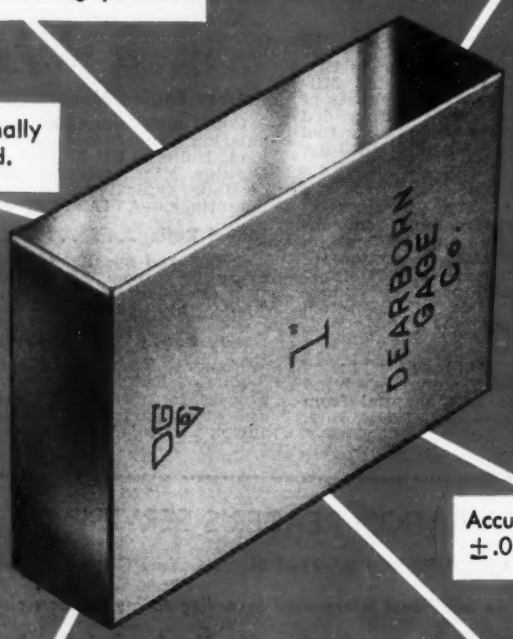

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ments of work and cutting tools, in any direction required and in any angular relationship.—AVIATION, July, '45.

Portable Surfacer **44**

Details of Model A-3 "Take-About" surfacer are contained in circular from Porter-Cable Machine Co., Syracuse, N. Y. —AVIATION, July, '45.

Wire Belt Hooks..... **45**

Bulletin from Bristol Co., Waterbury, Conn., describes wire belt hooks for flat belting and shows methods of applying. —AVIATION, July, '45.

Angle Molding Press..... **46**

Watson-Stillman Co., Roselle, N. J., offers Bulletin No. 642-A concerning angle presses for molding complicated parts by transfer method. Molding of plastic products requiring sp"+ ends is also considered.—AVIATION, July, '45.

Materials Handling **47**

Standard and engineered hydraulically operated materials handling equipment are shown in circular from Lyon-Raymond Corp., Greene, N. Y.—AVIATION, July, '45.

Die-Less Duplicating **48**

O'Neil-Irwin Mfg. Co., Minneapolis, has issued new catalog on "Di-Acro" system of die-less duplicating. Latest models of equipment are shown and improvements listed.—AVIATION, July, '45.

Thread-Milling Cutters **49**

Various types of ground multiple thread-milling cutters are listed in bulletin from Continental Tool Works, Detroit.—AVIATION, July, '45.

Decimal Equivalent Table **50**

For pocket use, Manufacturers Screw Products, Chicago, offers handy table of decimal equivalents of twist drills.—AVIATION, July, '45.

Toggle Clamp **51**

New catalog from Detroit Stamping Co., Detroit, contains description of new "De-Sta-Co." Model 610 push-pull lock clamp for heavy duty holding of work in jigs and fixtures.—AVIATION, July, '45.

Mercury Arc Converters **52**

Standard mercury arc converters for induction heating operations in 500-2000-cycle frequency range are described in Bulletin B6373 from Allis-Chalmers Co., Milwaukee.—AVIATION, July, '45.

Cable and Wire Stripper **53**

Lever type cable and wire stripper for use on synthetic, plastic, glass, and cambric insulation, is described in bulletin from Ideal Commutator Dresser Co., Sycamore, Ill.—AVIATION, July, '45.

Photo-Print Dryer **54**

Reported to efficiently dry matte, semi-matte, or glossy prints, also blue- or black-and-white prints, B-8 table-type continuous photo-print dryer is described in bulletin from Peck & Harvey, Chicago. —AVIATION, July, '45.

PLASTICS

Molded Plastics **55**

The Story of Plastic Molding, brochure from Chicago Molded Products, Chicago, is manual descriptive of various forms of plastics. Given are data on characteristics, information on molds and their manufacture, and details of company's service. —AVIATION, July, '45.

Liquid Polystyrene **56**

Recommended for doping, coating, impregnating, or sealing for radio frequency, ultra-high frequency, very-high frequency, or general electronic applications, "Polyweld", a pure polystyrene in solution, carrying product number "912", is announced in bulletin from American Phenolic Corp., Chicago.—AVIATION, July, '45.

Synthetic Rubber Sheet Stocks..... **57**

Fabrics & Finishes Dept., E. I. Du Pont de Nemours Co., Wilmington, Del., has issued technical service manual on "Fairprene" synthetic rubber sheet stocks.—AVIATION, July, '45.

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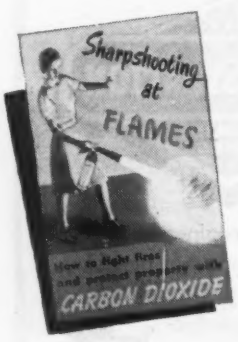

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Plastics Guide 58

A Businessman's Guide to the Molding of Plastics, booklet from Kurz-Kasch, Inc., Dayton, Ohio, offers suggestions on proper selection of materials and describes company's services in making of molds and production of parts.—AVIATION, July, '45.

ELECTRICAL

Electronic Tubes 59

New catalog from Taylor Tubes, Chicago, details complete line of electronic tubes, devotes several pages to their characteristics, and contains technical information.—AVIATION, July, '45.

Electronic Controls 60

Condensed listing of principal items of electronic control equipment made by Wheelco Instrument Co., Chicago, is contained in catalog.—*Wheelco Electronic Controls.*—AVIATION, July, '45.

Electronic Equipment 61

Contained in new catalog from Walker-Jimieson, Chicago, is information and data on latest types of electronic instruments, devices, and tools. Also available is new edition of company's *Industrial Available Booklet,* listing items available from stock on priority.—AVIATION, July, '45.

PARTS & INSTRUMENTS

Optical Instruments 62

Brochure, *Seeing It Through,* from Bausch & Lomb, Rochester, N. Y., describes company products and activities as related to the war.—AVIATION, July, '45.

Aircraft Accessories 63

Electric fuel, hydraulic, and air pumps and motors are described in booklet, *Aircraft Accessories for 400 Cycle Motor Operation,* issued by Pesco Products Co., Cleveland.—AVIATION, July, '45.

Portable-Unit Engine 64

Designed for equipment manufacturers who are building portable units, new aircooled engine has been developed by Kinner Motors, Glendale, Calif. Described in brochure is "Busy Bee", Model AB-3, a 4-cycle L-head type developing 5 hp. (2,600 rpm.) and 6 hp. (3,250 rpm.).—AVIATION, July, '45.

AIRPORTS

Runways 65

Application of the Principle of Dispersion to Portland Cement is title of research paper (No. 35) from Master Builders Co., Cleveland. Along with engineering data, paper describes company's cement dispersing agent, calcium lignin sulphonate, and explains its use with cement for runways.—AVIATION, July, '45.

Fueling Systems 66

Fueling pits, dehydrators, and submerged turbine pumps, items of fueling systems equipment for airports, are described in bulletins from Erie Meter Systems, Erie, Pa.—AVIATION, July, '45.

Portable Rotating Beacon.....67

Information is available on portable, mobile, rotating beacon made by Davey Compressor Co., Kent, Ohio. Beacon's 24-in. face is equipped with variety of snap-on lenses, shutters, and mountings which permit many functions, such as for airport beacon work, rotating or non-rotating, or for searchlight or signaling. Unit can be mounted on owner's truck.—AVIATION, July, '45.

Hangar Doors 68

New catalog from Byrne Doors, Detroit, describes line of hangar doors, movable steel partitions, and crane entrance doors.—AVIATION, July, '45.

AIRCRAFT TIRES

Care of Tires 69

Comprehensive information on care, repair, and maintenance of aircraft tires and tubes is contained in booklet from B. F. Goodrich Co., Akron. Several pages treat on preventive maintenance.—AVIATION, July, '45.

MERCHANDISING

Cutaway Display Units.....70

Service of Robert H. Kimes, cutaway engineers, Dayton, Ohio, is described in brochure. Engines, propellers, or other parts are cutaway to expose interior mechanisms for demonstration, training, or sales purposes.—AVIATION, July, '45.

MANAGEMENT & EMPLOYEES

Industrial Truck Safety.....71

To promote safe use of industrial power trucks, Elwell-Parker Electric Co., Cleveland, has issued list of 34 safety rules. —AVIATION, July, '45.

Metal Windows 72

Windows of metal to conform to modular planning are described in catalog from William Bailey Co., Springfield, Ohio.—AVIATION, July, '45.

New Fire Extinguisher 73

Bulletin from American-LaFrance-Foamite Corp., Elmira, N. Y., describes new "Alfite Speedex" carbon dioxide fire extinguisher made in three sizes and described as faster in action.—AVIATION, July, '45.

Welding Progress 74

In booklet *The Future of Welding*, Victor Equipment Co., San Francisco, explains scope of company's activities during war and plans for postwar.—AVIATION, July, '45.

Fire-Resistant Paint 75

Information on new fire-resistant paint, "Fi-Repel", is available from General Pacific Corp., Los Angeles.—AVIATION, July, '45.

Underground Pipe Conduit 76

"Thermo-O-Tile", conduit for underground hot and cold pipe lines, is described in bulletin from H. W. Porter & Co., Newark, N. J.—AVIATION, July, '45.

Rust Preventive 77

Developed to prevent rusting of steel tanks, piping, and other steel structures, "Rusta Restor," cathodic (electrical) method, is described in Bulletin No. R-181 from Johnson & Jennings Co., Cleveland. —AVIATION, July, '45.

X-Ray Protection 78

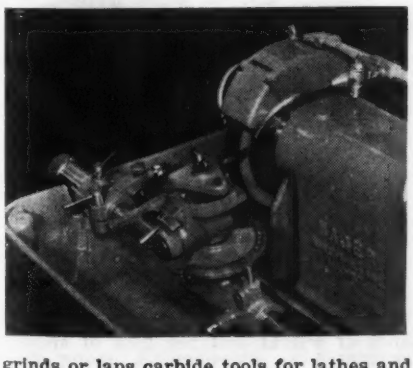
Covering lead products and X-ray and radium protection, technical literature is offered by Bar-Ray Products, Brooklyn.—AVIATION, July, '45.

NEW PRODUCTS

Latest Machinery

Carbide Tool Grinder 79

Based on principle of Swiss type grinders, carbide tool grinder made by **E. F. Hager & Son**, Queens Village, L. I., N. Y.,



grinds or laps carbide tools for lathes and screw machines, as well as tool bits with carbide tips inserted in milling cutters. When tool is clamped in adjustable holder and set by built-in protractors for cutting edge and clearance angles, uniform reciprocating action of tool across diamond wheel assures straight face and keen edge, states maker. Holder can be slid from rough grinding wheel to finish grinding wheel without removal. Fine adjustment controls feed of tool, and tool holder rest bar prevents tool from digging into wheel. Spindle speed f 3,400 rpm. is attained through V-belt from ½-hp. motor. Tool holder is mounted on shaft which pivots and slides axially in bronze bearings. Compression spring mounted in cup on other end of shaft causes constant thrust against micrometer nut. Thrust ball bearings on either end of shaft insure free pivoting.—AVIATION, July, '45.

Single Hole Perforator 80

For hole dia. from 1/32 to 1½ in., new single hole perforating equipment made by **S. B. Whistler & Sons**, Buffalo, consists of an alloy-steel hardened punch holder, four hardened and ground punch adapter rings to accommodate punches within range, semi-tempered steel die shoe, gage plate 16x24 in., four hardened and ground die adapter rings to accommodate die bushings to 1½ in., and four gages for positioning sheets to be perforated. Punches, dies, and strippers are not included but can be furnished.—AVIATION, July, '45.

Ball Bearing Grinder 81

Baldor Electric Co., St. Louis, has developed new 8 in. ball bearing grinder, Series 8100, features being described as substantial ¾ in. arbor, exhaust type guard, and best quality wheels.—AVIATION, July, '45.

Aircraft Parts & Field Units

Automatic Boost Control 82

Designed to protect aircraft engines from detonation or overstress, and to re-

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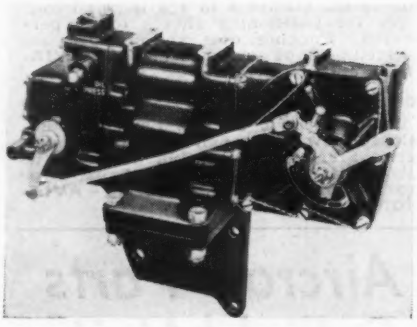


duce pilot fatigue, automatic boost controls developed by **Eclipse-Pioneer Div., Bendix Aviation Co.**, Teterboro, N. J., are for application to various single-stage single-speed, and single-stage two-speed supercharged engines. Maker states that, due to military restrictions, design and engineering data are available only to manufacturers approved by Government.—**AVIATION, July, '45.**

Ignition Transformers 83

For use in igniting fuel in gasoline-fired aircraft cabin heaters and for de-icers, three new 115v., 400 cyc. ignition transformers have been developed by **General Electric Co.**, Schenectady, N. Y. Units are shielded to minimize radio interference over all wave bands from 110 kilocycles to 200 megacycles. Two units, with output capacity of 6,000 v. each, are of single-secondary type, while third has double secondary, rated 6,000//6,000v. for heaters with dual ignition or for two separate heaters. Designed to withstand vigorous service, maker states they will operate over ambient temperature range from —70 to +140 F. at altitudes to 45,000 ft.—**AVIATION, July, '45.**

Black Light Lamps 84

Aircraft instrument illumination with black light through use of special lamps

is announced by **Sylvania Electric Products**, Salem, Mass. Lamps are for operation on 120v. a.c. and 24-28v. d.c. Near ultra-violet RP 12, rated at 4w., is designed for use with a visible light filter where lightweight, compact lamp is required. It is equipped with polarized bayonet base and may be operated in any position. Red-purple series tubular lamps require no visible light filter and operate with standard fluorescent lamp accessories on 120v. a.c. They are supplied with miniature bi-pin bases in five sizes ranging from 6 in. T5, rated at 4w., to 36 in. T8, rated at 30w.—**AVIATION, July, 45.**

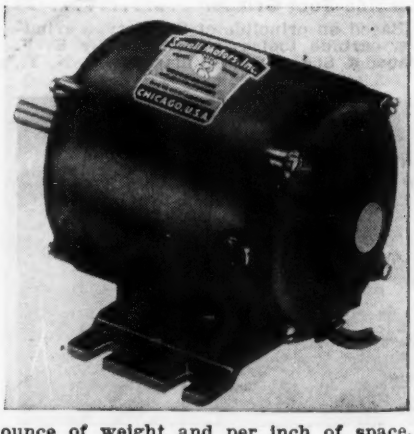
Cowl Door Track Roller..... 85

Reported to eliminate binding and jamming, new universal track roller for cowl and flap doors, and other sliding

members, has been developed by **General Engineering & Mfg. Corp.**, Newark, N. J. Rollers, of ¼ in. dia., are available in shaft lengths of ⅝ and 13/16 in., or to specifications.—**AVIATION, July, '45.**

Fractional HP. Motor..... 86

New small a.c.-d.c. aircraft appliance motor, made by **Small Motors**, Chicago, is designed to provide maximum power per



ounce of weight and per inch of space. Designated as SM-4 model, motor develops 1/50 to 1/10 hp. It is of 3 5/16 in. dia., 4 13/16 in. long, and 3⅞ in. high with rigid base. Weight is 3 to 4 lb. Speeds are from 2,000 to 10,000 rpm. with

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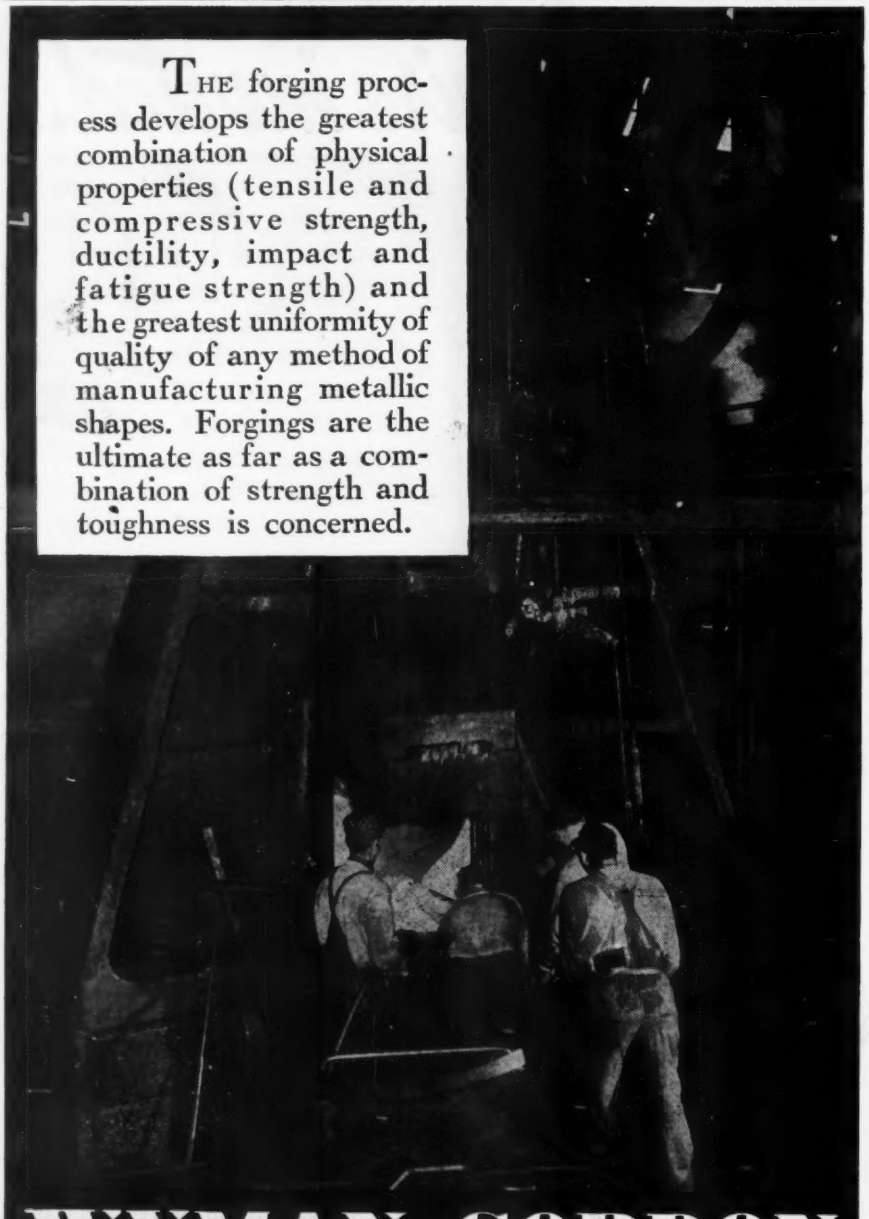

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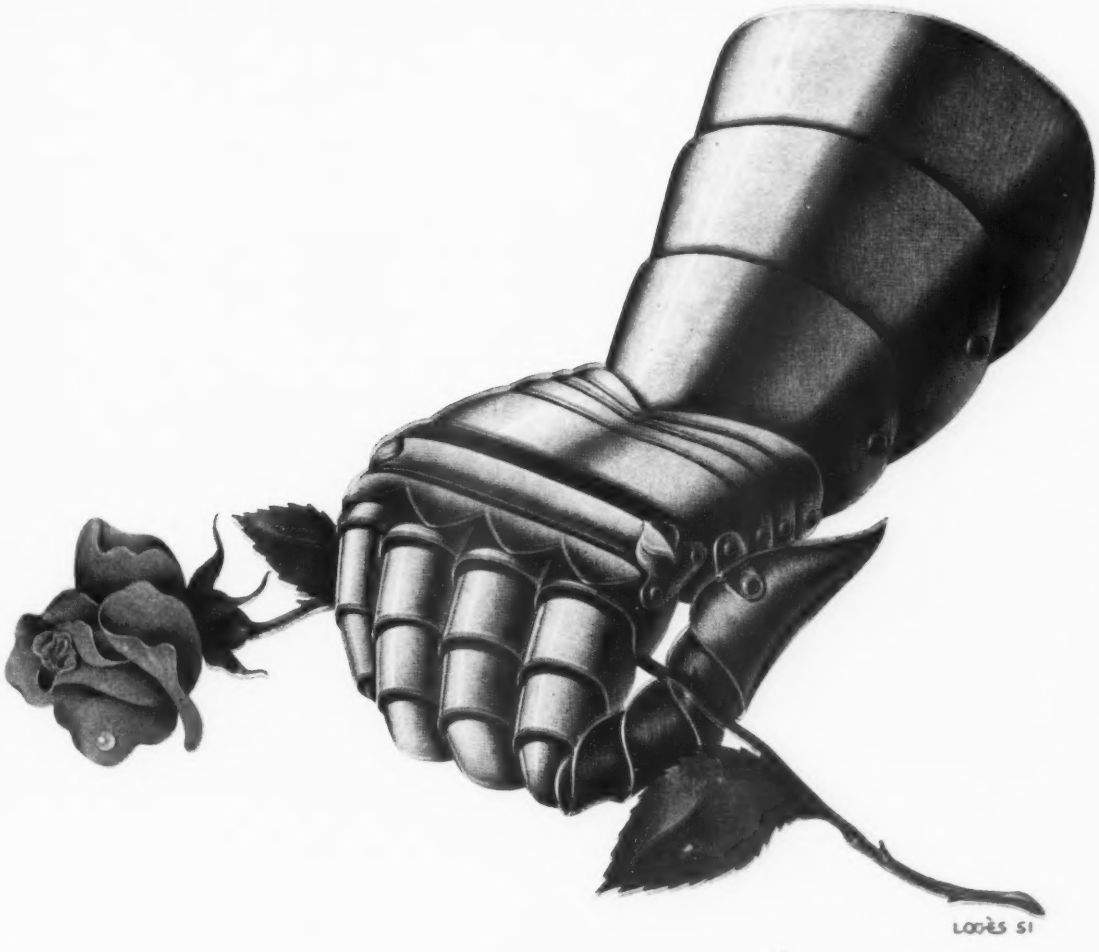

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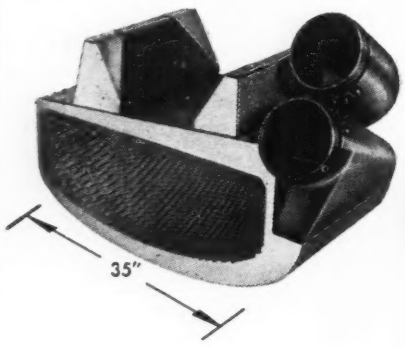
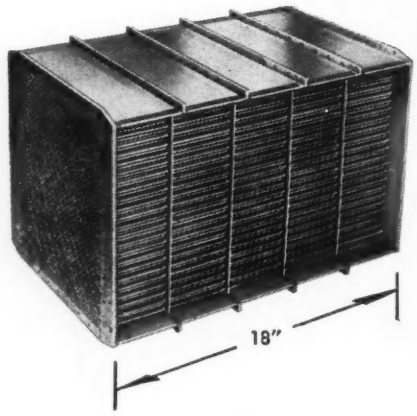
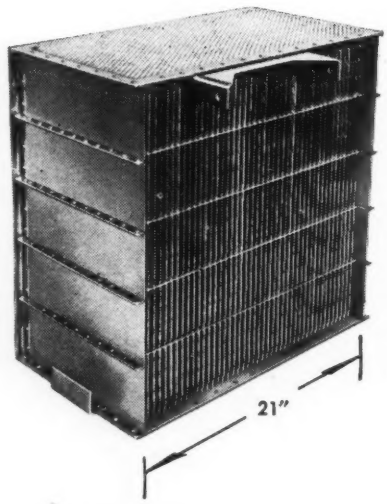
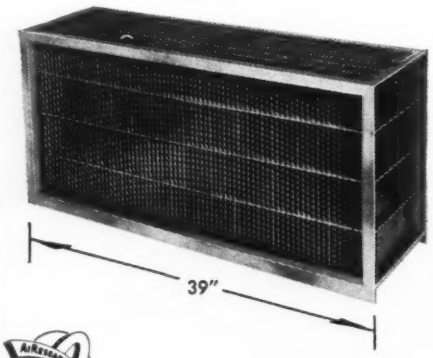
Farmingdale, L. I., N. Y. — *Makers of the Mighty Thunderbolt* — *Evansville, Ind.*









1,000,000 HOURS of combat performance already logged for AiResearch Intercoolers

THE *ONLY* COMPANY THAT CAN CLAIM SUCH A RECORD OF SERVICE

AiResearch is manufacturing supercharger Intercooler units for the P-38, the P-61, the B-17 and the B-29. These ships alone have logged well over a million combat hours, all trouble-free insofar as AiResearch Intercoolers are concerned. And AiResearch has designed and built numerous other models equally successful.

AiResearch designed the *first* mechanically assembled all-aluminum, corrosion-resisting Intercooler successfully put on a production line basis. The tubes are jig assembled and mechanically fastened for accurate control of dimensions. This method helps make them mechanically strong enough to withstand terrific back pressure.

Both round and flattened tube Intercoolers are standard products of AiResearch. The company's latest development is a flattened-dimpled tube unit used on the B-29, which has shown a remarkable increase in effectiveness and as much as a 40% reduction in cooling drag. Weight has been continually decreased. Intercoolers today weigh 30% less than earlier models.

These Intercoolers are tested in the AiResearch Laboratories under actual conditions of heat, cold and altitude. Lab performance and actual performance have been remarkably near the same. This experience in designing, testing and manufacture is available to other aircraft manufacturers and engineers who have an intercooling problem needing solution.

ARMY E NAVY

AiResearch — manufacturers of AIR CONTROL equipment
Cabin Pressure Regulating Systems • Engine Oil Cooling Systems • Supercharger Aftercooling Systems • Temperature Confrol Systems • Engine Intercooling Systems • Automatic Exit Flap Control Systems.

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LOS ANGELES • PHOENIX
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precision ball bearings, and 10,000 to 20,000 rpm. with oil-less sleeve bearings. Speed reduction features are built in to order. Motor is wound for any voltage from 6 to 250.—**AVIATION, July, '45.**

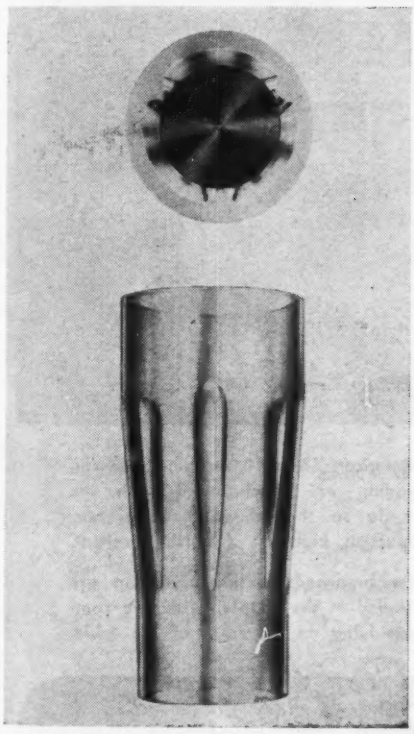
Electric Starter and Tester..... 87

For use in engine starting and accessory testing without batteries, electro starter made by **Kurz & Root Co.**, Appleton, Wis., is three-wheeled rubber-tired unit fitted with brakes and weighing about 1,200 lb. Motor, with input of 400v., is 3-phase, 60 cyc. a.c. Generator output capacity is 24-28v., 400-600 amp., d.c. Control panel has push button starter, rheostat for manual operation, and switch for automatic voltage regulator operation. Switch panel has two disconnect switches, providing 2 separate circuits so that two aircraft can be serviced at once.—**AVIATION, July, '45.**

Shop Equipment & Materials

New Rotameter Tube 88

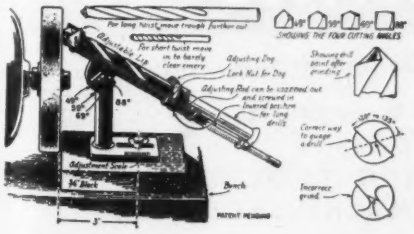
Three straight glass ribs running up inside tube to guide rotameter float throughout its travel distinguishes new rotameter tube made of boro-silicate glass. Manu-



facturer, **Fischer & Porter Co.**, Hatboro, Pa., states that centering float improves accuracy, prevents tube breakage, and permits float shapes that are not stable without guides. New tube can be adapted to existing type rotameters.—**AVIATION, July, '45.**

Four-Angle Drill Grinder..... 89

Designed to simplify difficult grinding operations, four-angle drill grinding attachment with improvements is announced by **A. D. McBurney**, Los Angeles.



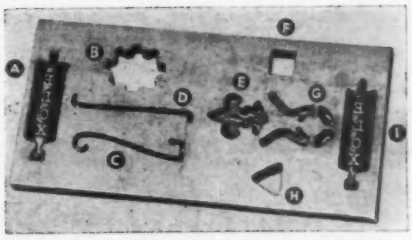
Fixture has vertical post and provision for grinding round shank drills in four point angles. 49, 59, 69, and 88 deg. Devised to hold drills from 3/22 to 1 1/16 in. dia., grinder will sharpen short, medium, and long twist drills from 1½ in. through 11 in. lengths.—**AVIATION, July, '45.**

Aluminum Cleaner 90

Reported to remove stamping inks from aluminum, and to help provide superior surface for welding, improved form of KDL No. 1, material for hot tank cleaning, is offered by **Kelite Products**, Los Angeles.—**AVIATION, July, '45.**

Spark Drilling of Shaped Holes..... 91

Elox Corp., Detroit, describes "disintegrator drilling," or drilling of shaped holes electrically, as same process as electrical disintegration of broken tools. Either solid or hollow electrode may be used. In illustration figures (F) and (H) were made with hollow electrode. Slots in figures (C) and (D) were formed by strip stock elec-

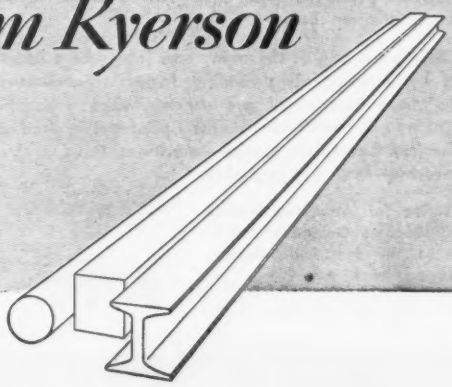


trode. Figures (B) and (E) were drilled by custom-made solid electrode.—**AVIATION, July, '45.**

Hermetically Sealed Instruments... 92

Hickok Electrical Instrument Co., Cleveland, announces 2½, 3½, and 4-in. round style electrical instruments, hermetically sealed and with internal pivot construc-

WAR STEEL... *quickly from Ryerson*



Special aircraft alloys, NE alloys, Allegheny Stainless—literally thousands of kinds, shapes and sizes of steel are available on short notice from Ryerson stocks. Bars, plates, sheets, tubing, structurals are cut or otherwise prepared to exact specifications. Eleven plants—eleven stocks assure prompt delivery throughout the nation. Call Ryerson first, whatever your steel requirements, for effective cooperation.

RYERSON STEEL

Joseph T. Ryerson & Son, Inc. Plants: Chicago, Milwaukee, Detroit, St. Louis, Cincinnati, Cleveland, Pittsburgh, Philadelphia, Buffalo, New York, Boston.

RYERSON CERTIFIED STEELS

Broaching by *American*

PROVEN in war . . .

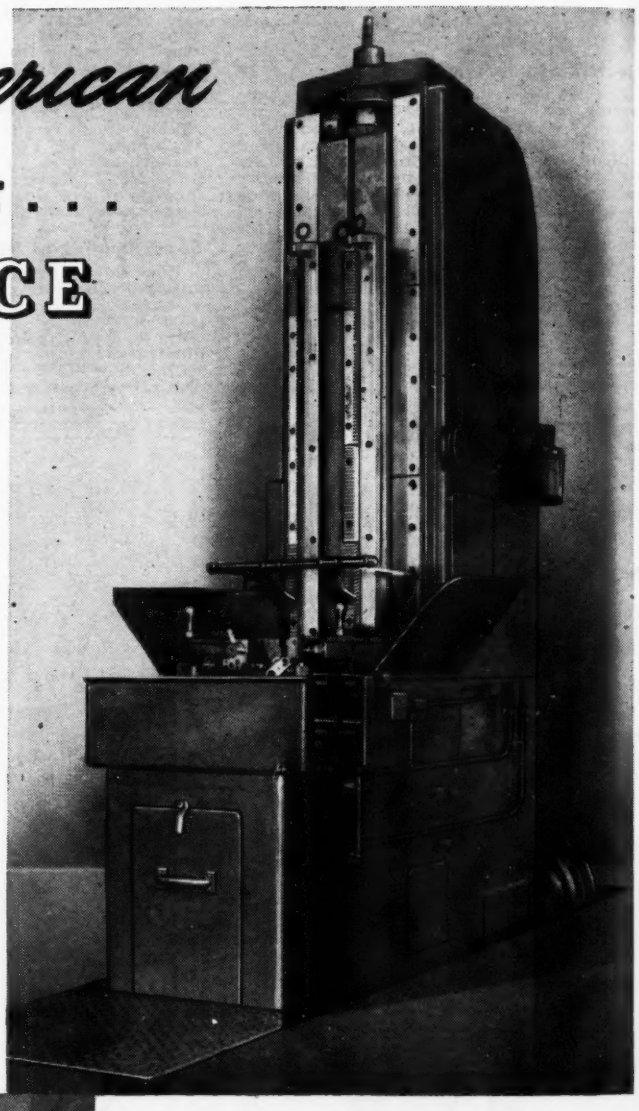
Ready for PEACE

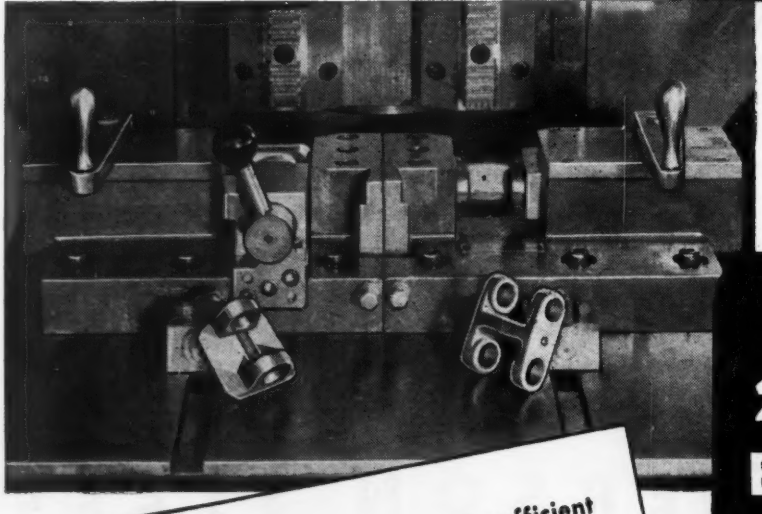
When war's demands made necessary precision production on a mass production basis, many leading production engineers turned to broaching—by *American*.

A typical example: finishing the surfaces between the bosses on aircraft universal joint parts. American Broach and Machine Company engineers—identified with broaching since the turn of the century—assumed responsibility for complete broaching equipment for this job. An *American* SB-54-10 single ram machine with receding work table was provided, equipped with a two station fixture designed to broach two end parts and one center part for a balanced production in each two machine cycles. (See illustration below.)

This is but one of the many war jobs where broaching by *American* is providing faster, more accurate and more economical production. When production planning is undertaken for peacetime products, *American*'s complete service—machines, tools, and engineering—will be available.

Write for American Broach and Machine Company's Tribute to the Aviation Industry. Address Dept. AV.





(Above) *American* SB-54-10 Machine. Loading and unloading are synchronized with the machine cycle so that down time is zero . . . production high . . . finish excellent.

(Left) Parts broached in this operation are shown installed in the fixture, with two completed parts lying on the front of the table.

Use proper and sufficient lubrication when broaching. It is cheap life insurance for broaching tools.

American

BROACH AND MACHINE CO.

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•

BROACHING MACHINES
PRESSES
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SPECIAL MACHINERY

DIVISION OF

tion. Those 4-in. round are for use in radio service equipment where several scale arcs are required; they have body dia. of 3½ in. and flange dia. of 4½ in., taking mounting hole radius of 1-15/16. Among instruments are voltmeters, ammeters, milliammeters, and microammeters, a.c. and d.c. All sizes are housed in metal cases, hermetically sealed with dry air at sea level pressure, or with inert gas. Terminals are glass soldered-in type, glass being direct-bonded to metal. Use of "Alnico" magnets permits use on steel panels. Maker states instruments will operate properly at 85 deg. C.—**AVIATION, July, '45.**

Roughness Standards 93

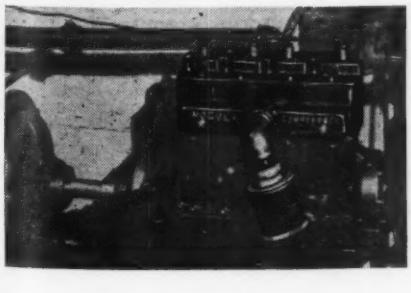
Containing a 65-page educational text bound to a gage consisting of 20 replicas of machined surfaces (prepared by turning, grinding, milling, honing, lapping, and polishing) which vary in roughness from 500 to 5 micro-inches (photo, right), "Surf-Chek" Roughness Standards provides method of designation from engineer's instructions and is stated to enable rapid and efficient roughness comparisons without need of instruments. Maker is **Surface Checking Gage Co.**, Hollywood, Calif.—**AVIATION, July, '45.**

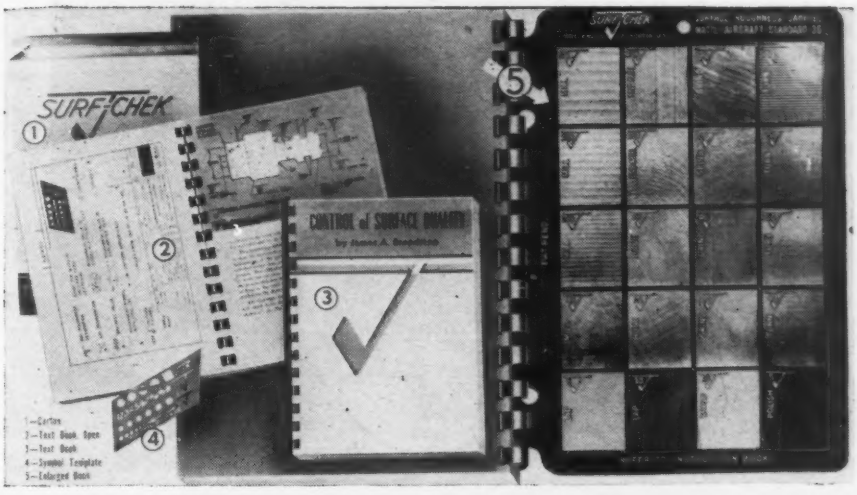
Plug Gage 94

New "DuBo" gage is bore checking gage of fixed limit type. Sizes from .240 in. to 1.510 in. dia., have "Go" and "No Go" members attached to opposite ends of lightweight metal handle, while sizes from 1.510 in. to 6.010 in. dia. are single end gages, individually mounted on palm-fitting plastic handles. "Go" members are marked with green enamel, and "No Go" members with red, under transparent plastic ring. Handles of double-end gages also have dots of color. Gage head is thin disk which is section of sphere. Gaging surface makes contact with bore walls only at instant and point of bore gaging. Two chamfered sections, diametrically opposed on each member, enable operator to enter gage into bores easily and almost to bottom of blind bore. Chamfered edge also tends to wipe away foreign material from gaging area. As gage can enter bores smaller than its dia., it checks out-of-roundness and taper. When checking bore for lower limit, "Go" member is entered with handle held lightly and tilted slightly above axis of bore, then lowered gently. Undersize spot arrests handle, and oversize spot allows handle to drop freely. Upper limit checking is done in same manner, using "No Go" member. Maker is **Standard Gage Co.**, Poughkeepsie, N. Y. Photo shows gaging of highly finished bore of bronze airplane bushing.—**AVIATION, July, '45.**

Compresor Head 95

Designed for use on Model A or B Ford motor block, Mogul model 105 com-





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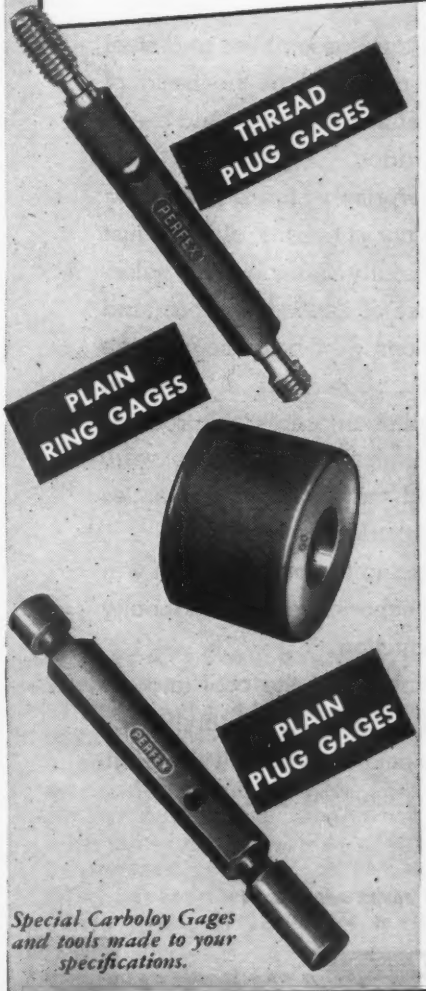
USE PERFEX CARBOLOY GAGES!



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We are pleased to announce that the *Carboloy Company* has granted us a franchise to use carboloy in the manufacture of our gages.

We consider this as another big step forward in our continual efforts to offer the highest quality, longest wearing gage possible to produce.

LOOK AT THESE ADVANTAGES!

1. Gaging costs per piece is reduced.
2. Users report 15 to 20 times longer wear.
3. Lower inventories required.
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Write for prices and delivery dates today

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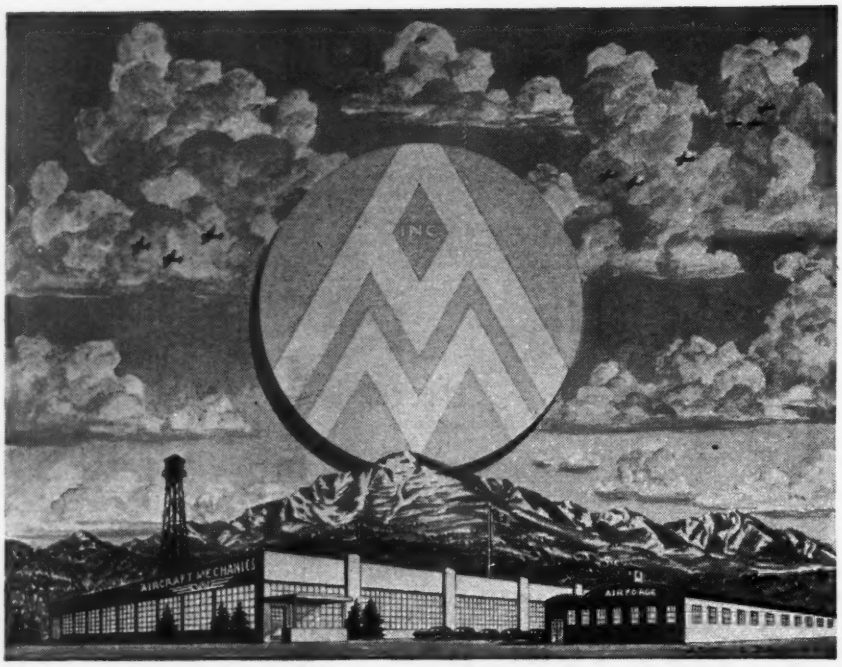

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Situated in the Famous PIKES PEAK Region!

Precision manufactured structural assemblies and steel forgings for aircraft are being produced in the heart of one of the world's most famous summer playground areas —the Pikes Peak region of Colorado.

Development here of an enterprise which is producing for Uncle Sam's Army and Navy air arms did not just happen! Our planning purposefully included the selection of Colorado Springs because of its ideal year-around climate and working conditions . . . because of the wealth of manpower available . . . because of excellent transportation facilities for supplies and finished products . . . and—because, personally, all of us long ago were convinced that the area offered many plus-opportunities for an engineering and manufacturing enterprise.

Today, our efforts are devoted to the production of war goods. Tomorrow, our ability, experience and ingenuity will be devoted to civilian production.

Meanwhile, if it is your plan to visit the cool and delightful Pikes Peak region this summer, let us invite you also to visit our plant, and inspect for yourself the engineering and manufacturing facilities we offer.

BUY UNITED STATES WAR BONDS AND STAMPS

*** AIRCRAFT MECHANICS** INC.

COLORADO SPRINGS, COLORADO

DESIGNERS . . . ENGINEERS . . . MANUFACTURERS

pressor head is offered by **Metallizing Co. of America,** Chicago. It is designed to enable recovery of scrap blocks. Head is designed to deliver volume of 139 cfm. with actual delivery of 100 cfm. at 100 lb. pressure. Unit includes valve and water chambers, air intake manifold, air strainer, unloader, pilot valve, and necessary parts for assembly.—**AVIATION, July, '45.**

Centrifugal Pumps 96

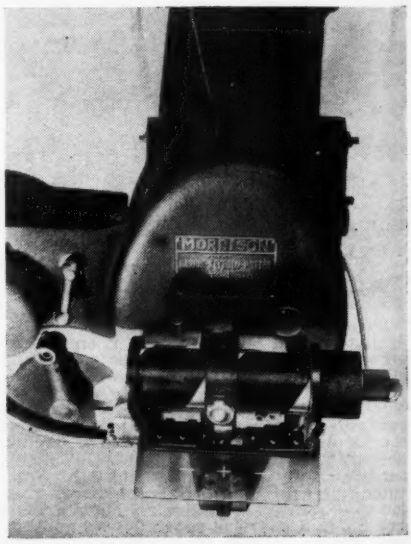
Higher volume delivery per hp. and ease of maintenance are reported features of new line of "Superflo" centrifugal pumps made by **Gray-Mills Co.,** Chicago. Heavy duty motors are mounted integrally, ranging in sizes of 1/25, ⅛, ¼, and ½ hp., with volumes of 9 to 75 gph. Thirteen basic models are available, with various voltage characteristics. There are types for horizontal-external mounting and for vertical-external mounting. Other pumps with floating impellers are made for submerging in coolant system reservoir. Bearings and pump seals are stated to require no lubrication.—**AVIATION, July, '45.**

Unit Cleans Engines and Parts..... 97

New degreasing tank for aircraft engines and parts may be wheeled to plane for insertion of engine. Made by **Process Equipment Engineers,** Belding, Mich., "Dee-Greaser" is stated to be entirely new in design. It uses air agitation for cleaning and can be equipped with air driven slush gun. Small trays may be inserted for small parts. Tank employs distillate plus chemical cleaner, both harmless. Residue is water soluble, hence washes off easily after soaking. Unit is offered in several standard sizes. Other models may be built to specifications.—**AVIATION, July, '45.**

Stitch Finder 98

New attachment on aircraft stitchers locates position of stitch visually by means of light reflected in form of cross and in one or two adjustable spacing lines if desired. Reflection appears on sheet of transparent plastic which is really a trans-



parent mirror so adjusted that cross appears to be on work exactly where top of stitch will be. After first stitch, work is moved either to right or left so stitch is covered by line of light. Maker, **Harris-Seybold-Potter,** Dayton, Ohio, states device eliminates use of gages and fixtures. —**AVIATION, July, '45.**

Fire-Fighting Nozzle 99

New dual-stream nozzle announced by **Dugas Div., Ansul Chemical Co.,** Marinette, Wis., is described as permitting operator of company's wheeled model extinguishers to apply dry chemical either as long range straight stream or as short range fan stream. Overhead fires can be extinguished successfully, reports maker. —**AVIATION, July, '45.**

Spotwelding Tweezers 100

Developed to weld radio tube wires, Besco spotwelding tweezers made by **New Jersey Jewelers' Supply,** Newark, N. J., have found applications on many other small, precise units, such as instruments

for aircraft. Tweezers are of copper, forged and insulated, having plastic covered, flexible, copper leads terminating in pair of lugs which connect in place of regular welding electrodes. Copper jaws, held like ordinary tweezers, are brought in contact with parts to be welded, then foot switch is pressed, current applied, and weld is made. Tweezers operate from ½ to 1 kva. on 10 amp. current, and they are used with timer.—**AVIATION, July, '45.**

Parallel-Resistance Calculator 101

Slide-rule calculator, developed by **Allied Radio Corp.**, Chicago, provides means of determining reciprocal of sum of two reciprocals as expressed by formula $\frac{1}{x} = \frac{1}{a}$ plus $\frac{1}{b}$. Single setting automatically aligns all pairs of a and b values which will satisfy equation for any given value of x. Calculator indicates in one setting the numerous pairs of resistances which may be connected in parallel, or capacitances in series, to provide any required resistance or capacitance value. Range is 1 ohm to 10 megohms, 10 mmfd. to 10 mfd. Capacitance and resistance figures on rule can also serve to represent inductance, impedance, reactance, or other units.—**AVIATION, July, '45.**

Tap Saver 102

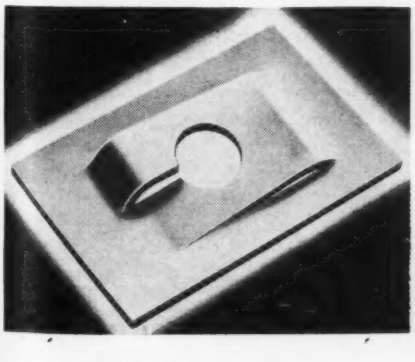
Reported to practically eliminate tap breakage where this factor has been very high, safety insert for tapping heads, made by **Topflight Tool Co.**, Towson, Md., is grooved piece of soft alloy metal which replaces steel jaws formerly used to hold tap. Insert, made in one piece, is used only for one size tap in any kind of head. When tap jams, soft metal of insert slot cuts away, permitting tap to remain stationary while head continues rotating. By rotating insert to new position each time tap jams, same insert may be used many times.—**AVIATION, July, '45.**

Laboratory Oven 103

Designed for precision experimental work in drying, baking, evaporating, polymerizing, aging, and heat treating, compact and self-contained oven is offered by **Industrial Oven Engineering Co.**, Cleveland. Sizes of working space range from 3x3x3 ft. to 6x6x6 ft., in increments of 1 ft., with special sizes to specifications. Temperatures range up to 900 deg. F., with guaranteed differential of ± 2 deg. Any type of fuel may be used.—**AVIATION, July, '45.**

New Lock Nut 104

Adel Precision Products, Burbank, Calif., announces "Stalock," new self-locking nut for sheet metal fastening, described as one-piece resilient-spring-steel stamping which grips screw threads all around with 360-deg. engagement.—**AVIATION, July, 45.**



New Air Driven Motor.....105

Described as developing more than twice piston thrust force of Model BM5 on given air line pressure, Model BM10 air motor, made by **Bellows Co.**, Akron, Ohio, has been designed on same basic principle of integral valve, operating, and speed controls.—**AVIATION, July, '45.**

Plastic Gage Collets 106

Metal collets are replaced by colored, dialectric, plastic collets in cylindrical plug gages made by **United Precision Products Co.**, Chicago. Green color identifies "Go" plug, and red the "No Go." Both plugs are in same handle. Maker reports plastic collet grips plug with more secure hold, stating it cannot be twisted out with vise or wrench, but is easily removed by use of drift. "Dublife" gage is reversible.—**AVIATION, July, '45.**

Carbide Insert Blast Nozzle.....107

American Foundry Equipment Co., Mishawaka, Ind., announces full line of blast nozzles for high service life. They are equipped with Norbide boron-carbide inserts, jacketed in abrasion-resisting alloy steel.—**AVIATION, July, '45.**

Air Filter Cleaner 108

Reported to eliminate use of distillate and other materials which leave offensive odors, new process for chemical cleaning of air filters in aircraft has been developed by **Turco Products,** Los Angeles. Filter is immersed for 6 min. in "Aktiv" solution, hosed off with cold water, dried with compressed air, then dipped into special oil.—**AVIATION, July, '45.**

Deburring Process 109

Parts of brass, magnesium, aluminum, steel, iron, castings, and stampings, also precision-machined parts, are stated to be uniformly deburred and smoothly finished by process developed by **De Burr Barrel**

WAYNE will offer every facility for the safe, accurate, speedy service of any type or size of airplane in one or more of the Wayne Refueling Systems which will be available as soon as wartime restrictions are lifted. There will be "packaged units" complete with pump and meter for tank trucks all ready for installation. There will be cabinet type systems similar to the one illustrated above, 15 GPM to 200 GPM with many new features of convenience as well as specially engineered systems for fueling at speeds of more than 200 GPM (at low pressure) using the new Wayne High Lift Pump. Write today if you have a refueling problem.

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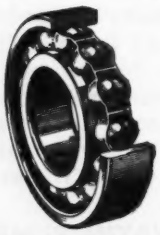
WAYNE *Airplane* REFUELING SYSTEMS

Nothing Rolls Like a Ball . . .

According to the annoyed gentleman above, that's *bad.* According to his opponent, that's *good.*

And, according to Industry, faced with ever-new problems of higher speeds, heavier loads and greater precision, that's the answer to many prayers.

For the *ball* bearing is fundamentally different. It is outstanding for free-rolling, precise location of parts, for simplified design, with low maintenance costs.



In millions of applications, New Departure Ball Bearings are proving their unique fitness for the new scheme of things mechanical.

We know of no other bearing that has as many advantages as the *ball* bearing. Particularly the *ball* bearing backed by New Departure's experience and technical skill.

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Our 112 page illustrated book "Why Anti-Friction Bearings" is mighty interesting. May we send you a copy?

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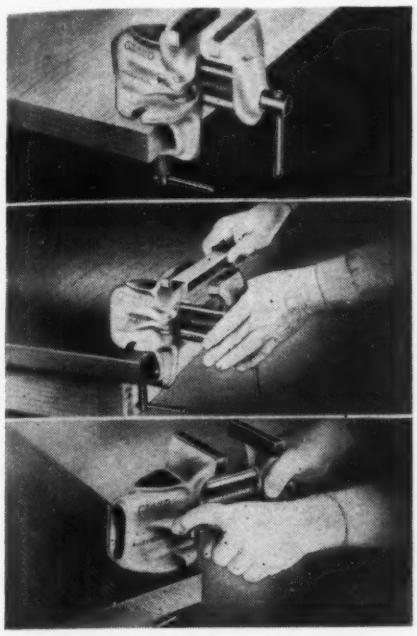
NEW DEPARTURE • DIVISION OF GENERAL MOTORS • BRISTOL, CONN. • Branches in DETROIT • CHICAGO • LOS ANGELES and other principal cities

Co., Los Angeles. "De Burrettes," used in tumbling barrels, are made of soft synthetic rubber, impregnated with aluminum oxide abrasive. Maker states that since each particle of abrasive is rubber mounted, cutting action is cushioned, soft metals are not marred, and a constant, even pressure provides fast cutting action on hardened steel.—AVIATION, July, '45.

Quick-Action Vise 110

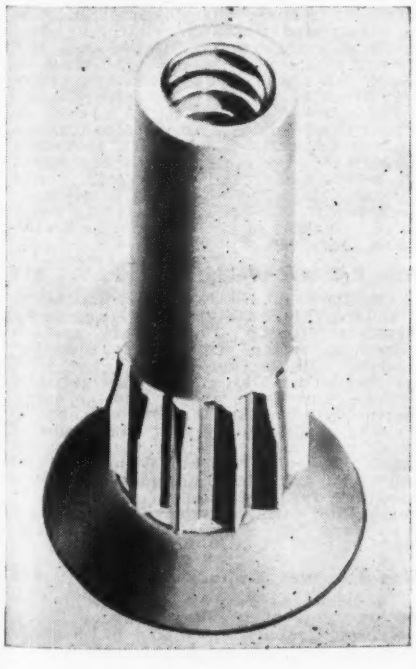
Action is stated to be speeded with new "Quikcet" alloy-steel machinist's vise made by **Grand Specialties Co.**, Chicago. Trigger release pawl enables running free



jaw in and out without use of screw. Screw is held under spring tension, and maker states vise opens instantly to full 3-in. cap. at a touch after single turn of handle.—AVIATION, July, '45.

New Type Fastener 111

Addition to line of "Rivnuts" manufactured by **B. F. Goodrich Co.**, Akron, is splined type for use in wood, plastics, leather, hard rubber, or other materials. Splines beneath countersunk head supply resistance to torque, while bulge or upset which forms below end of splines furnishes tension resistance, locking nut in two ways. Internal threads left intact within shank take attachment screw for installation of accessories. Standard tools are used. Three sizes of nut are available —6/32, 8/32, and 10/32, in aluminum or brass.—AVIATION, JULY, '45.



ANNOUNCEMENTS—

of new machinery, shop equipment and materials, electrical appliances, and aircraft parts and field units are invited.

In writing, emphasis upon specific aviation applications of newly-marketed items is desirable. Also, whenever possible, glossy-print photos should be enclosed. Please do not send electros. Address —
New Products Editor, AVIATION
330 W. 42d St., New York City 18

Over-Capacity Step Collets 112

Zagar Tool Co., Cleveland, announces over-capacity step collets for both 1- and 2-in. fixtures. No. 301 2-in. collets are made in 3, 4, and 5 in. sizes, and 1-in. collets in 2, 3, 4, and 5 in. sizes. No. 301 collets (2 in.) can be used wherever type "C" collet is used. Heads are 1 in. thick, are made of M-tempered tool steel, are finished ground complete, and are left in soft condition. Heat treating instructions are included.—AVIATION, July, '45.

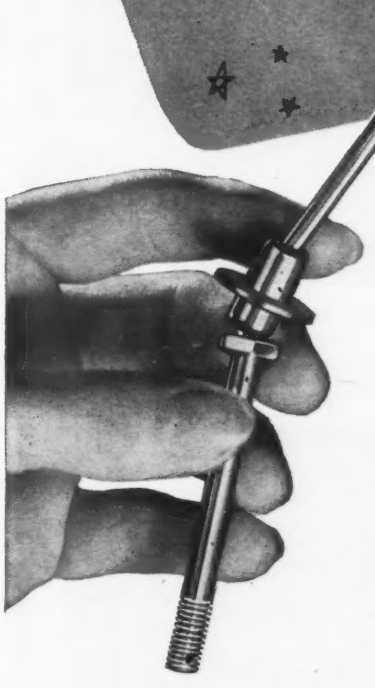
Container Grease Gun.....113

An original grease container can be converted into 25 lb. high pressure grease gun through attachment of Model 1266 "Handi-Luber", states manufacturer. Device is compact high pressure pump equipped with hose assembly and hydraulic coupler. Manually operated and developing 5,000 psi., it dispenses light cup grease or viscous types. Maker is Lincoln Engineering Co., St. Louis.—AVIATION, July, '45.

Taper Boring Atachment 114

Designed for easy mounting on any hand screw machine or turret lathe, and on some Bullard and chucking machines,

This Stem Assembly Attests Arnolt's *Sub-Contracting* Skill



Tolerances for most of the nine parts of this stainless steel and brass carburetor diaphragm *stem assembly* do not exceed ±.0005". After assembly, the ends turn freely, but end play is held to within .0025".

Arnolt facilities, used in mass-producing this precision unit, include centerless grinding machines, turret lathes, drill presses, automatics, and swaging, turning and milling machines.

Arnolt has the skill and facilities to make parts for your wartime or postwar products.

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WARSAW, INDIANA

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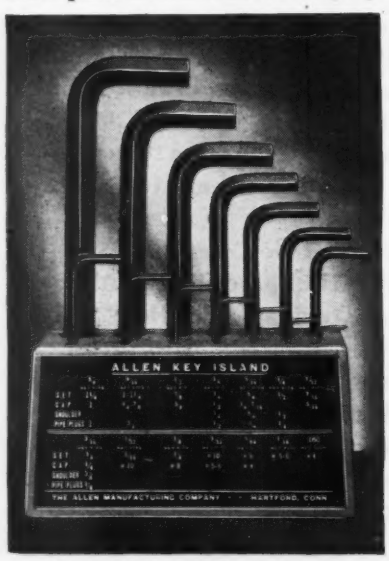
Key Kits

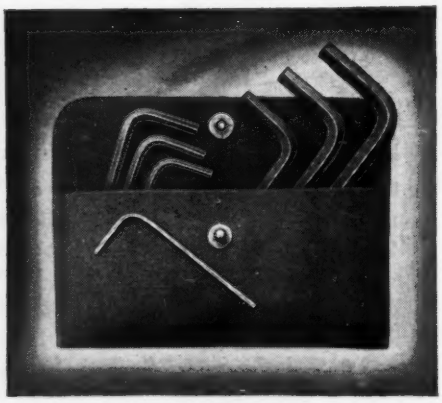
Key Assortments to fit Hex-Socket Screws in the range of sizes the airplane mechanic needs everyday.



KEY ISLAND This handy key set contains 14 keys fitting all sizes of set screws up to and including 1¼"; cap screws up to 1"; shoulder screws to 1" and pipe plugs to 1". Container is labeled to show correct size key to use with each screw. No. 615; list price $2.35.

Ask for complete listings of Allen Hollow Screw Assortments and Key Kits. Address inquiries and orders to Dep't. A,

KEY SET No. 603: This canvas partitioned bag contains 11 short arm hexagonal keys which fit all screws from and including No. 10 up to and including 1¼" diameter set screws. List price $1.75.



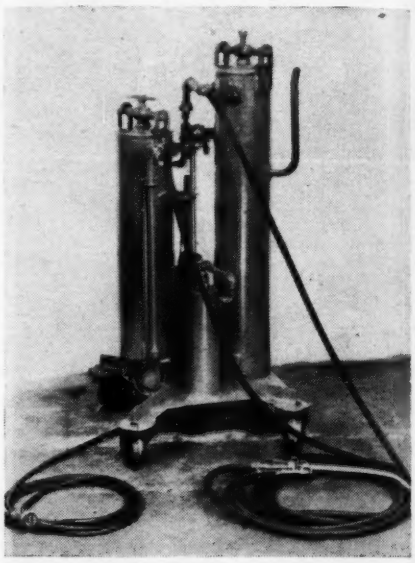
JUNIOR KEY KIT No. 604: Seven short-arm Allen Keys are included in this strong leatherette envelope. They fit the hex holes of sizes Nos. 8, 10, ¼", 5/16", 3/8", 7/16" and ½" set screws and Nos. 4, 5, 6, 8, 10, also ¼" and 5/16" cap screws. List price only $0.50.

THE ALLEN MANUFACTURING COMPANY
HARTFORD, ★ ALLEN ★ CONNECTICUT, U.S.A.

new turret attachment for boring tapers and profile holes is reported to produce perfect tapered or straight holes without change in setup except moving back top slide. Only care reported required is to maintain same dial setting, specified to remain constant regardless of length of stock. Maker is **Artisan Tool & Cutter Co.**, Ferndale, Mich.—**AVIATION, July, 45.**

Aero Engine Storage Preparer.....115

Designed to prepare aircraft engines for storage by spraying entire inside with oil, Model PA 787 aircraft engine preparer is announced by **Airplane Mfg. & Supply**



Div., Pacific Airmotive Corp., North Hollywood, Calif. Oil is heated by an immersion heater, and air is filtered through silica-gel contained in separate pressure tank. Working pressure of 30 lb. of air is required. Unit is portable.—**AVIATION, July, '45.**

Electrical Appliances

Voltmeter-Ammeter 116

Combined in case, a.c. voltmeter and a.c. ammeter provide readings of both current and voltage simultaneously. Instrument is Model 601 voltammeter made by **Associated Research**, Chicago. Ammeter measures from 0.2 to 500 amp. in 8 current ranges: 0-1, 0-5, 0-10, 0-25, 0-50, 0-100, 0-250, and 0-500. Voltmeter measures from 30 to 600 v. in three ranges; 0-150, 0-300, 0-600, and it can be used on d.c. at these ranges. An inserted primary current transformer with 8-ft. secondary leads facilitates measurement of current on 0-100, 0-250, and 0-500 amp. scales without subjecting meter to stray magnetic fields. Size of case is 12½ x 9½ x 10 in. Weight is 25 lb., packed.—**AVIATION, July, '45.**

New A.C. Arc Welders.....117

Two new a.c. arc welding machines, Standard 161 and Standard 251, made by **Ergolyte Mfg. Co.**, Philadelphia, are designed to replace company's "plug in" models. Maker emphasizes ease with which whirlwind air cooling assembly and cyclone automatic arcing assembly can convert either of new machines to specific welding needs, stating that by addition of these units, four different machines are made. Standard machines plus fan and conversion accessories provide a.c. welding machines for continuous welding or machines that strike a quick arc with practically any type of rod.—**AVIATION, July, '45.**

Non-Resonant Capacitors 118

Described as advantageous in filtering or bypassing over wide frequency bands, "Hypass" capacitors made by **Sprague Electric Co.**, North Adams, Mass., are

stated to show no resonance at frequencies as high as 50 megacycles and, in many instances, up to 300 megacycles. Capacitors are installed by connecting in circuit in same manner as low-pass filter would be connected. Two terminals are connected in series with circuit, with container grounded. They may be used to eliminate "hash" in many circuits.—**AVIATION, July, '45.**

Electromagnetic Engraver 119

Aircraft industry uses for new electromagnetic free-hand or pantographic engraving tool are: Marking parts for selective assembly or position in assembly; placing timing marks on flywheels; gang lay-out work on sheet metal or plastics; cutting of irregular shapes from thin sheet aluminum, steel, or brass shim stock and from thin metal, paper, or composition gasket material. Maker is **Electro Mag. Mfg. Co.**, Rockford, Ill. —**AVIATION, July, '45.**

Alloy Cast Connectors.....120

New alloy called 113L, for cast current-carrying parts of electrical connectors, is described by maker, **Burndy Engineering Co.**, New York City, as its alloy 113 with lithium added, which strengthens parts materially, since casting is denser and finer-grained.—**AVIATION, July, '45.**

Magnet Driver Units.....121

In permanent magnet driver units manufactured by **University Laboratories,** New York City, features reported as exclusive are: Molded diaphragm flexing surfaces, stated to outlast metal; heatproof voice coil suspensions; and hermetically sealed dust covers, spun over entire unit structure, giving waterproof protection. Also described as important

is rim centering of voice coil assembly in magnetic gap to give permanent positioning of voice coil assembly. Model PAH (illustrated) is rated 25w., impedance is 15 ohms, and frequency is 100 to 6,000 cyc. Dia. is 5¼ in., height 5 in., and weight 9 lb. Model SAH is rated 25w. Impedance is 15 ohms. Frequency is 100 to 6,000 cyc. Dia. is 4½ in., height 5 in., and weight 5 lb.—**AVIATION, July, '45.**

"Sizing" Overhaul Shops

(*Continued from page* 181)

operations required. Perpetual shifting of workers would bring about slow sections in the line and inefficiency. With continuous flow overhaul, time and production are of the essence.

As mentioned previously, the sample overhaul depot under discussion employs about 1,200 people, 38 percent of whom are women. Inspectors number 130. Not included in the original figure are the several other groups, such as production control, material coordination, and the methods department. Some sections may work two or three shifts, although such schedul-

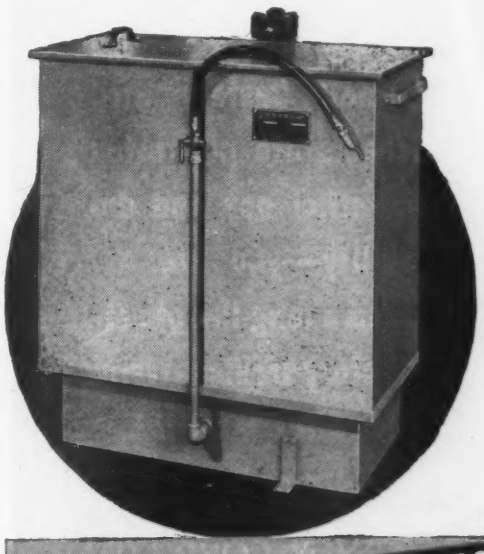
in Parts Cleaning that means

***Circo Chief* Degreaser**

Speed combined with thoroughness in parts cleaning means greater production, less man hours, less effort, lower costs, higher profits, and that's exactly what you get with the new Circo Chief twin tank degreaser. Circo Chief's time schedule is minutes instead of the usual hours wasted in cleaning parts, a savings in time alone that will pay for the unit. This remarkable parts cleaning degreaser cleans dirty, greasy parts five different ways—hot vapor cleaning (automatic), spraying (automatic), drying (automatic), soaking and dipping, choice of which depends upon condition of parts.

Circo Chief automatically hot vapor cleans and dries greasy parts in three minutes, and that means every nook and corner of all parts are thoroughly cleaned.

Anyone can operate a Circo Chief degreaser as it heats automatically, starts and stops automatically, and automatically feeds itself solvent for vapor degreasing and drying. The new modern Circo Chief degreaser sets a new pace in fast, thorough parts cleaning, producing big savings in man hours and material, and a profitable "pay-off" on every parts cleaning job. Economical to buy and to use.



We would be glad to forward free literature on the Circo Chief degreaser. it's yours for the asking—write today.

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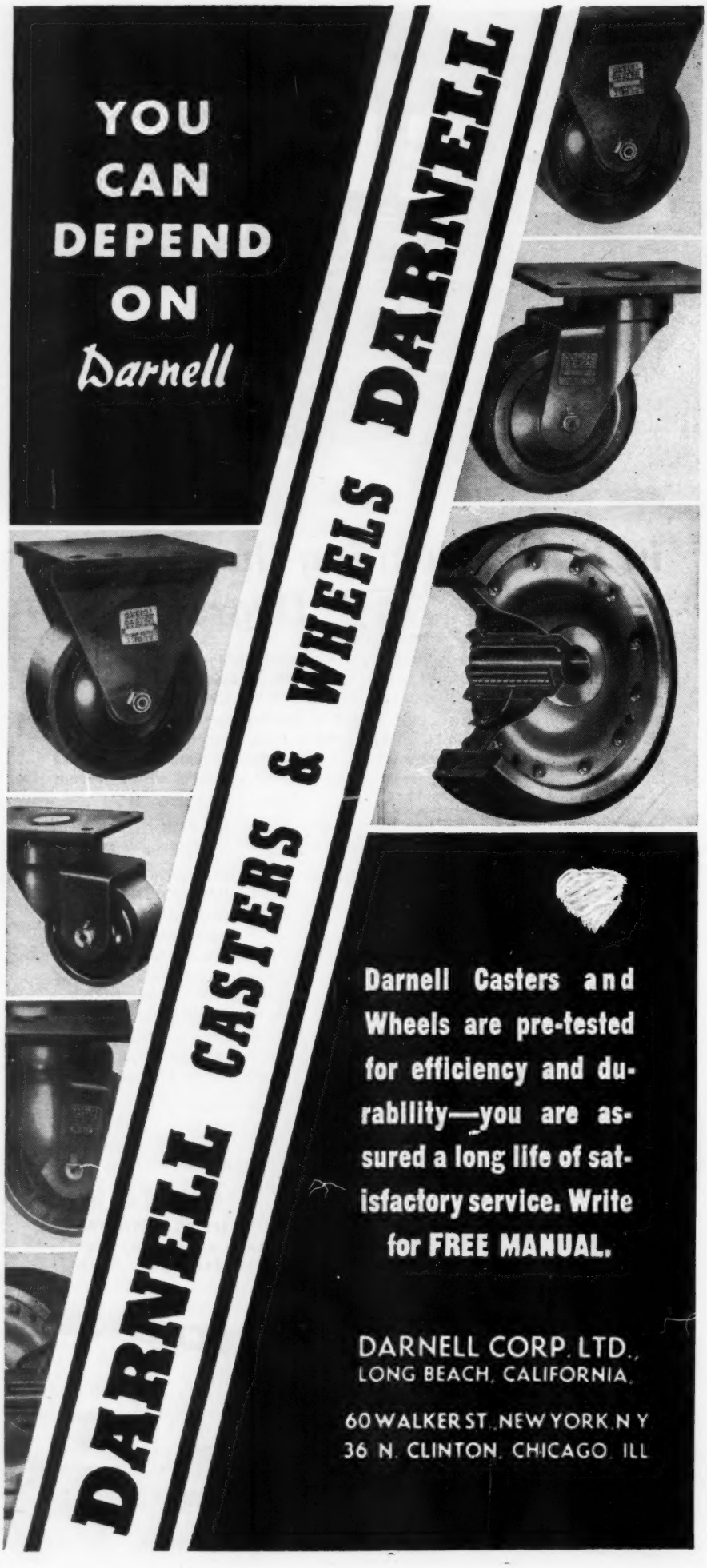
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ing is usually confined to the machine shop and engine test sections. A conception of the contrast between this and the small airline shops may be gained by comparing the latter's 100–150 overhauls per year with the figure of about 50 engines torn down per shift in the continuous-flow shop.

Organization of the large shop is quite involved, as indicated in the diagram of Fig. 2.

In general, this kind of shop functions in a manner closely approaching the production systems found in manufacturing plants. Parts move along conveyors from station to station, without regard to individual engine numbers. Workers are not expected to set up machines or jobs for themselves. Specific instruction sheets furnish them with every detail of their particular task. Tools are checked out and mounted on backboards with identifying markings. Certain exceptions to this tool system are applicable to supervisory personnel and machinists.

Engine storage and preservation is of paramount importance to large shops, and paradoxically enough promises to be quite vital to the small shops expected to spring up after the war. Any overhaul operator who receives engines from far distant shipping points and who must either return or store them will have the corrosion problem to beat.

Continuous-flow overhaul is a distinct, integrated industrial process with little room for individual craftsmanship. It produces a work volume unobtainable by other methods, but it makes it extremely difficult to fix responsibility, and it does not turn out the painstaking quality of work expected from the smaller shop.

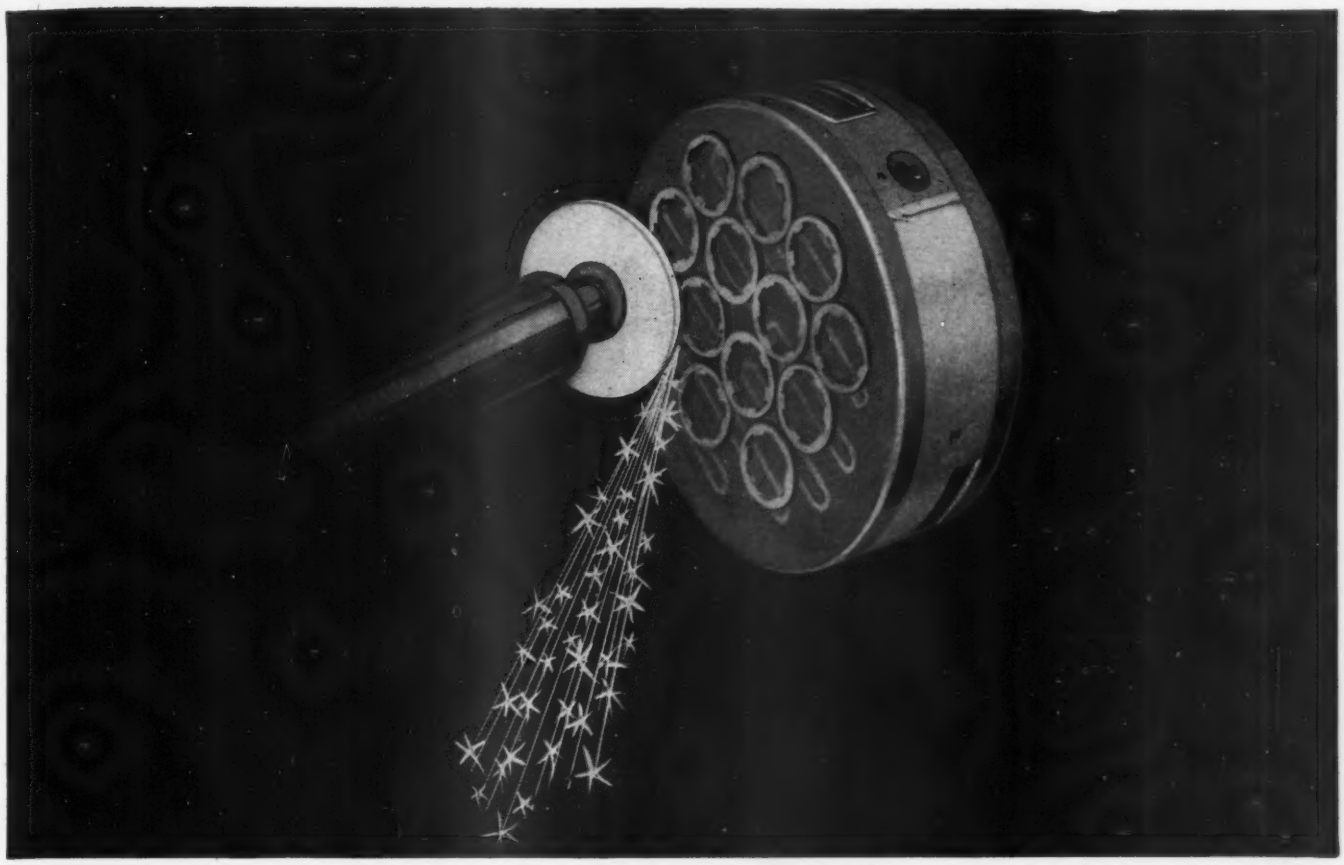
Aircraft Dividends

(*Continued from page* 112)

Such stocks as Bell Aircraft, Curtiss-Wright A and common stocks, Glenn L. Martin Co., and North American Aviation have been selling to yield better than 10 percent on the basis of their present dividends, while Beech, Consolidated Vultee, and Lockheed have sold to give almost as high a yield. Even Boeing, which appears among the best situated for big volume operations for the duration of the Pacific war, currently sells to yield almost 10 percent.

The aircraft stocks generally are selling for less than their net working capital and also less than five times their 1944 net income after taxes. Ten times earning power is often cited as a yardstick for stock market prices.

Why is it that the aircraft stocks



GANG UP ON 'EM

For multiple surface grinds as well as internal, external and taper grinds or turns, the Lempco Model ACX Convertible is an ideal low-cost machine tool. Many important exclusive features: automatic power cross-feed; screw and rack and pinion infeed; rapid and easy change-over from turn to grind or vice versa; longitudinal adjustment of work-head for various size jobs; 18" swing. Good delivery.

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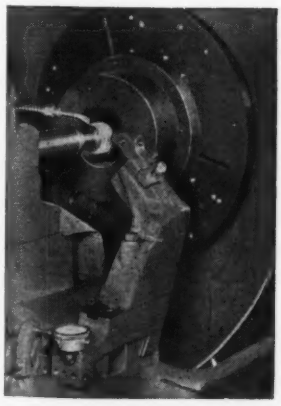

AUTOMATIC SIZING DEVICE

Dial indicator sizes directly from work diameter. Makes it simple and easy for spindle to exactly duplicate successive pieces on long runs. Eliminates spoilage and saves valuable man-hours.

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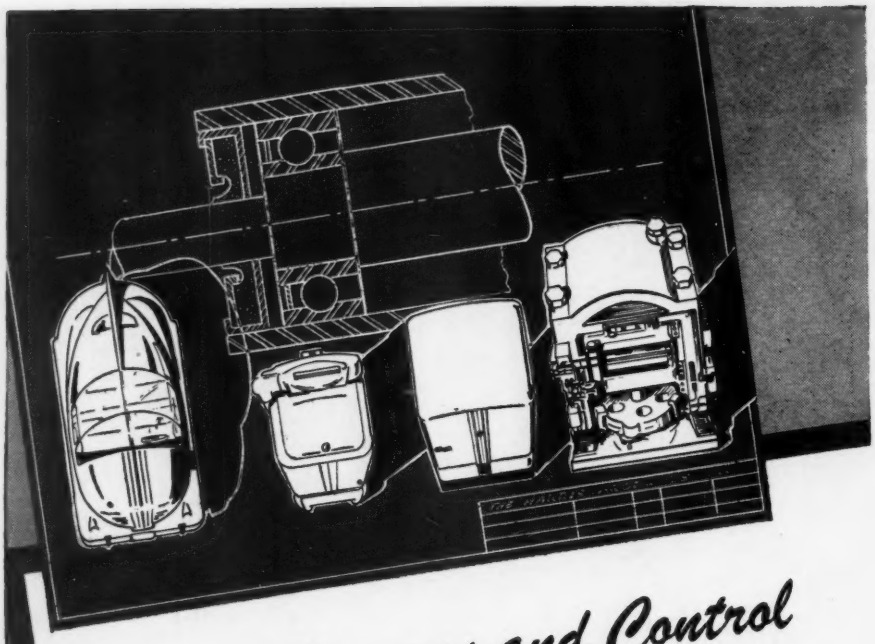
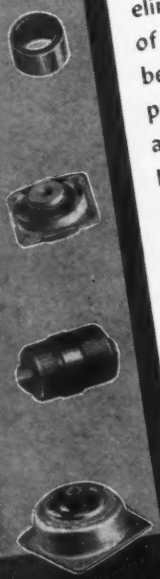


How to Harness and Control VIBRATION NOISES

Today, vibration control on postwar equipment is a major subject with most of the leading equipment and appliance manufacturers because it adds greatly to the longevity, efficiency and performance of their products. Vibration control also means quiet, smooth operation which in turn is a potent sales point in selling appliances of all kinds.

Harris Torflex Flexible Bearings will prolong life, lower maintenance costs, insure more dependable and accurate operation and increase efficiency. This is done by absorbing shock, controlling vibration, silencing noises, providing flexibility for cushion and misalignment, transmitting torque, and eliminating wear and friction. Harris Torflex Bearings consist of a seamless tube of rubber which has been stretched between two concentric metal tubes, assuring high radial pressure which provides the required adhesion between rubber and metal. Torflex Bearings take axial, torsional, and radial loads and come in a wide range of sizes, carrying loads from ounces to tons. They are widely used and universally approved.

Harris pioneered in the field of engineered vibration control, consequently Torflex Flexible Bearings and Harris Mounts are widely used on prewar equipment, Army and Navy planes, military mobile units of all kinds, industrial equipment, automobiles, electrical and electronic products. If you have a vibration problem, our engineers would welcome an opportunity of working with your engineers, just drop us a line.



HARRIS PRODUCTS CO.
CLEVELAND 4, OHIO
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give the largest yield of any single group on the New York Stock Exchange? It is because Wall Street has regarded the wartime earnings and dividends of the plane makers as only transitory ever since the war began. Brokers feel that wartime earnings will merely represent "paper profits" unless the companies come through the war in good financial condition.

Thus, as far as the aircraft companies are concerned, Wall Street is interested primarily in their financial positions, how well they weather termination and reconversion problems, and their postwar prospects.

It seems to be generally assumed that the long-term future of the industry is fairly bright in that annual volume eventually will be much larger than it was before the war. Right now the problem is one of cutting back to size.

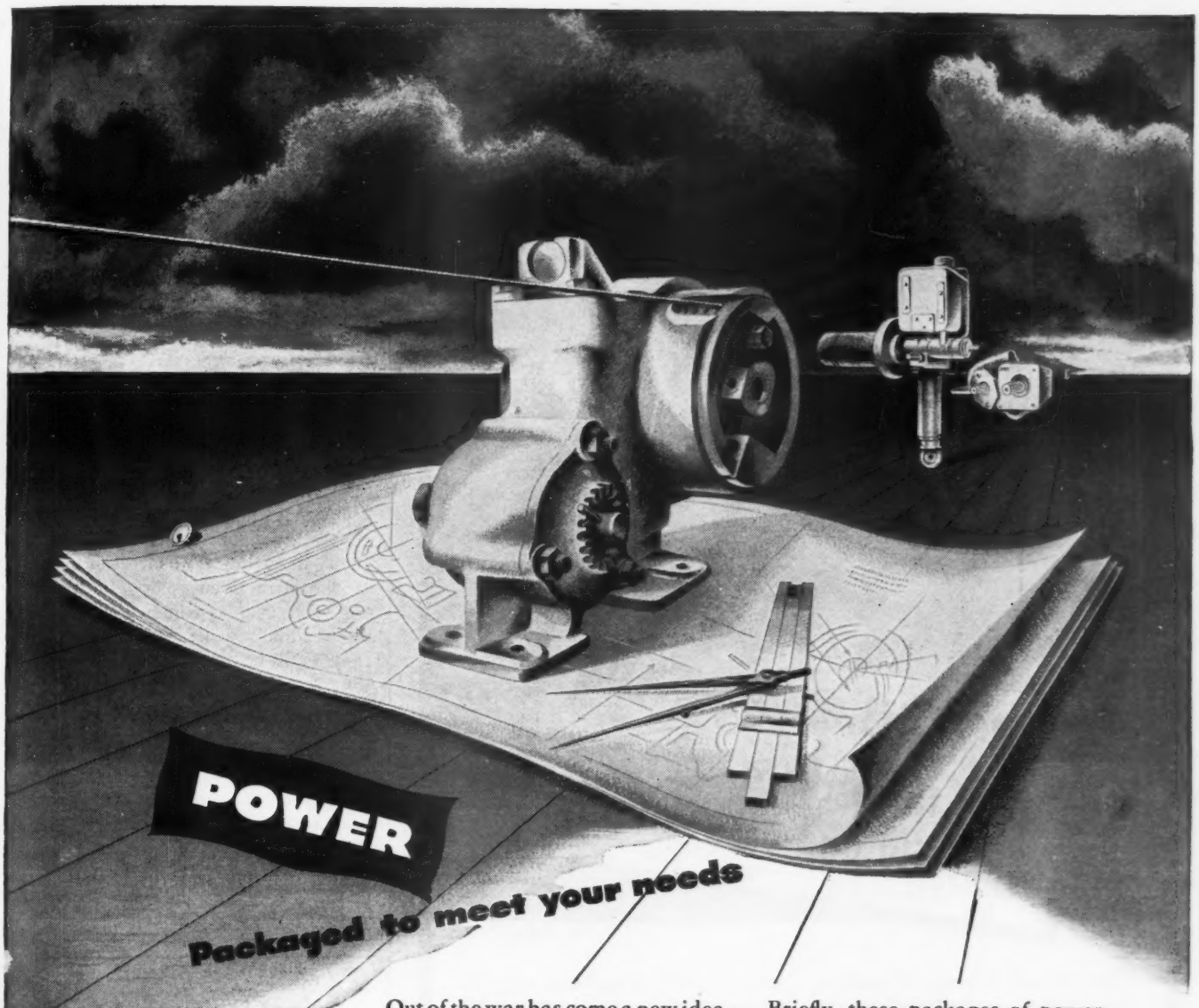
It is conceded that much has been done both by government and the industry during the past year to smooth out reconversion problems. Surplus disposal policy remains about the biggest hurdle to be straightened out. So there is much less talk today of the coming struggle for the industry's survival than one heard two years ago. But the industry didn't pull any punches then in telling Congress and the public what would happen if reconversion and termination plans were not set up. Congress and the war agencies were impressed and acted. Wall Street and investors generally were also impressed and are still thinking of those dire warnings.

So the fact that most of the industry has salted away substantial reserves for the inevitable rainy day hasn't made much of an impression yet on Wall Street. Unnoticed is the fact that the industry has had to make surprisingly little use of the new termination loan devices set up by Congress.

But if the industry had not greatly improved its financial condition in the last two years, the aircraft shares would be selling lower than they are today. And action such as United has taken to fortify further its financial position cannot help but have a favorable effect on the stockholder's position.

Not until Congress indicates its postwar aircraft procurement policy can the future prospects of the average company be evaluated with any degree of accuracy. In the meantime aircraft stocks must be rated on their balance sheet condition as much as on any other factor.

Up to now the aircraft and the airline companies have followed pretty much the same path in capital financing. In both cases, new capital has been obtained largely through the sale



Out of the war has come a new idea in the application of power. In cooperation with aircraft manufacturers, Foote Bros. engineers have developed small power units, compact in size, light in weight, yet exerting tremendous force. These power units are designed for accessory drives and to open and close ventilators, trim stabilizers, operate wing flaps, and perform many other jobs that otherwise would have to be done manually.

Right now in development in the laboratories at Foote Bros. are other applications of these power units—applications on peacetime machines and equipment—that will mean more efficient operation—that will result in definite competitive advantages.

Briefly, these packages of power can actuate lineal or rotary motion positively, either by direct or remote control. They may be designed to have an operating force of a few pounds or several tons—they may do one job or simultaneously perform many.

For the machines or equipment you are manufacturing or planning to manufacture, Foote Bros. power units may assure you greater operating efficiency, more compact design, lighter weight, or better engineering. They may simplify your design problems and even make a design practical that without them would be impractical.

Foote Bros. engineers will gladly discuss the application of power units to your equipment.

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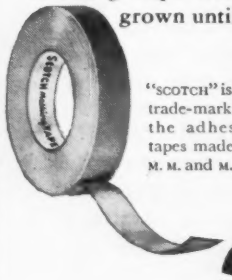

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of stock. From here on their paths will diverge quite sharply. The tendency will grow among the airlines to finance working capital needs through medium-term loans.

But the manufacturing concerns, aside from the ample credit available to finance war contract terminations, will continue to do the larger share of future public financing through the sale of common or preferred stock. Fortunately war production hasn't had to be financed through big stock issues, and preferred stocks are still the exception rather than the rule in the industry.

The availability of equity capital for aircraft manufacturing will depend upon the prospects for profitable operation after the industry has shrunk back to its normal size and upon the general availability of new capital for equity financing. The effect of taxation on the attractiveness of risk-taking is one of the factors which will determine the readiness with which new equity capital can be obtained in any industry. Congress appears in a mood to be helpful in that respect.

Certainly there have been times in the past when the aircraft industry was in a worse plight than it is today, despite its manifold problems. The period of reconversion has already started for some companies. There seems to be every indication that the storm will be weathered.

Tunnel for Sonic Speeds

(*Continued from page* 157)

¼ in. between the shafts and a change of 2½ in. in the gap between them, to allow for expansion and strain in the tunnel structure.

The drive shaft is enclosed in a 22 ft. long steel tube, one end of which is welded to the tunnel shell and the other to the upstream nose of a 12-ft.-dia. 50-ft.-long nacelle housing the fan shafts, bearing mounts, hubs, and sockets of the fans.

Airflow in the fan section is through the annular space between the nacelle and the tunnel shell, directed by the twelve upstream vanes and by six straightening vanes a short distance downstream of the fans. Tabs on the straightening vanes make possible very accurate adjustment of the airflow.

Basic unit of the fan power system is a variable-speed d.c. motor of 2,000 hp., supplied by a motor-generator set. Power requirements beyond the capacity of the basic unit are supplied by an a.c. variable-speed induction motor having a wound rotor and slip rings, and a short-time capacity of 10,000 hp. Speed and torque of the latter are ad-

justable by means of a liquid rheostat slip regulator.

The three model-support systems are types commonly used in wind tunnels, their special features resulting largely from the necessity that they be mounted on the movable carts, yet permit easy connection to, and separation from, the metrical system. This is accomplished by a jacking system acting on the four legs of each cart, the floor of which comprises the bottom of the working section.

When a loaded cart is in position, it is lowered electrically by the jacks until the model and its supports are resting on the metrical or force measuring system. Jacking is continued until the cart is disconnected from the model and is attached to the tunnel structure. Upon completion of a test, the connection with the metrical system is broken at disconnect plugs, and the jacks disconnect the cart from the tunnel structure and pick up the model supporting system. Then the cart, driven by motors on the frame, moves out of the working section on rails.

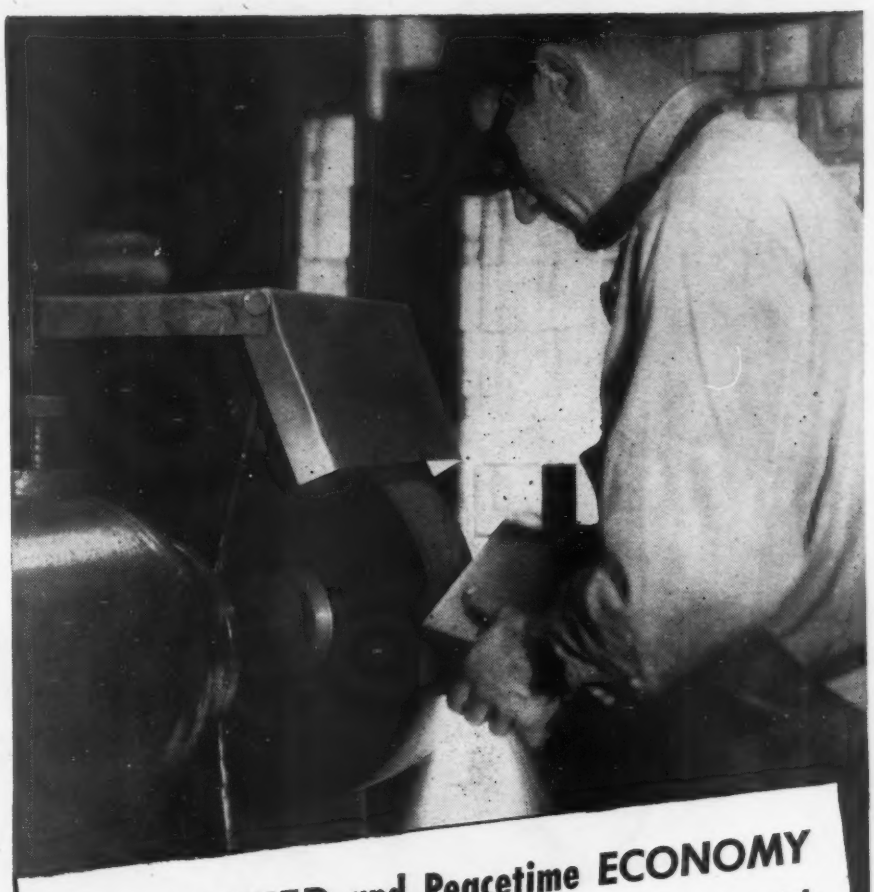
The metrical system, which weighs more than 50,000 lb., is entirely contained within the structural shell of the tunnel and operates at pressures both above and below standard atmosphere. The lowest member of the system is a triangular frame resting on three supports in the bottom of the spherical shell surrounding the working section. Between the main frame and these supports are load measuring-capsules.

On the upper surface of the main frame are three circular, flat pads upon which rests a large ring which is accurately machined flat on both top and bottom surfaces. During operation, oil is pumped into the pads, supporting the ring on a thin film of oil. The dynamic form of oil support is similar to that used on the 200 in. telescope on nearby Mt. Palomar, and was chosen because of its extremely low coefficient of friction.

Horizontal forces on the airplane model—drag or cross-wind—are applied to the metrical system and transmitted to the large ring which, unless restrained, would slide on the oil pads. The ring is restrained by a drag link and two side force links which, in turn, are connected to the main frame through force-measuring capsules.

The drag link, running along the tunnel axis, measures drag directly. The two side force links lie perpendicular to the tunnel axis and are so arranged that the sum of the force increments on the links gives the crosswind force on the model.

In order to rotate a model in yaw, a vertical axis is established on the large ring and the whole ring is rotated by means of a remotely controlled worm



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and gear drive with the large ring rotating on the flat pads of the main frame. The worm gear housing is connected to the main frame through the side force links, and is stabilized by them.

Resting on top of the large ring are three additional oil pads. These are spherical in shape and have as their center the center point of the tunnel, the midpoint of the line connecting the top of the two main model support arms. On these spherical pads rests a moment table, through which all of the model forces and moments pass—transmitted through the pads and taken out as previously mentioned. The moments would tend to make the moment table rotate in the spherical oil pads, so restraining is achieved by means of links between the table and the ring, each link being connected to a force-measuring capsule.

Along the axis of the tunnel one link is used to measure the model pitching moment, and across the tunnel axis two links are used, spaced some distance apart. The sum of the forces in these two links is a measure of the rolling moment, while the difference gives the yawing moment on the model. The spherical oil pads are double acting and thus form a spherical cup which completely restrains the model.

The top of the moment table is the line of separation between the metrical and suspension systems. Having the system level is of extreme importance to avoid errors in drag force readings. Through the use of tiltmeters the pads are kept level to 1 part in 200,000. Thickness of the oil film in the pads is also recorded in the control room because that, too, is involved in keeping the system level.

The force indicating system is a new application of the Southwark-Tate-Emery method of hydraulic weighing and remote indication of forces.

Essentially, the weighing system consists of nine new-type Emery capsules in the suspension system. The Emery capsule is primarily a rigid cylinder and piston unit having a 0.10-in. clearance and less than 0.002 in. stroke. Forces exerted on the capsules are balanced by hydraulic pressures developed within the capsules, and the resulting pressure changes are transmitted to the indicating system.

Hydraulic connections from the weighing sides of the capsules transmit pressures to the sensitive elements in the Tate-Emery indicator cabinet in the control room. Combinations of pressure-sensitive elements in each indicator permit weighing pressures to be added, to give the sum, or subtracted to give the difference of the pressures due to forces being exerted in the tunnel suspension system.

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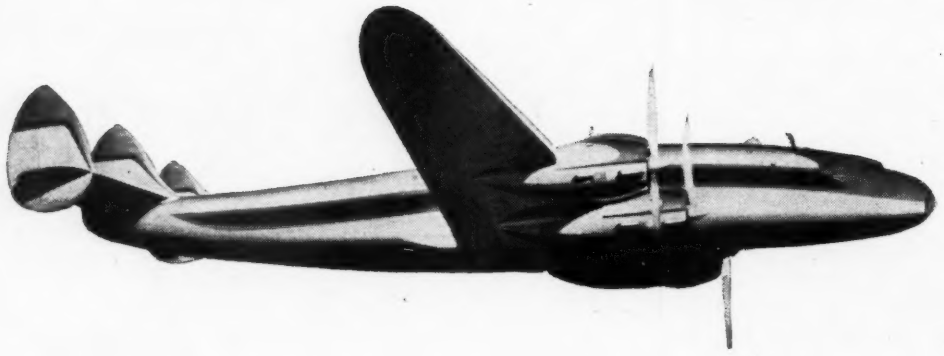

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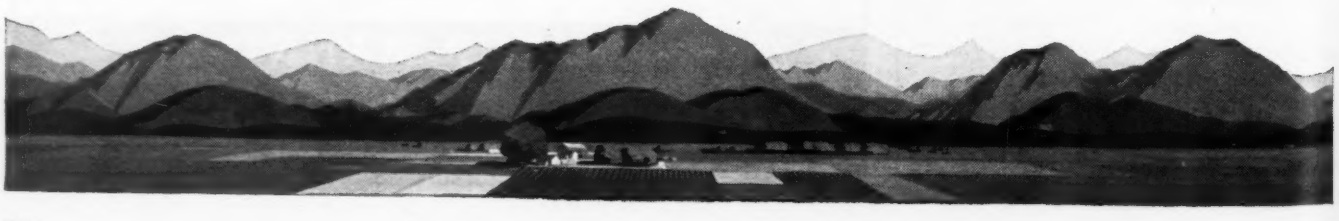

Specially developed automatic measuring and recording machines, precented to Cal Tech by International Business Machines Corp., permit continuous display, in true numerical form, of test data, also automatic recording of such data by printing on a worksheet and by punching in record cards. Subsequently the cards are processed rapidly by IBM standard equipment to apply mathematical corrections and to transform the test data into dimensionless coefficients for study by aerodynamicists.

Nine IBM followup units are provided, seven being applied to weighing gages which measure the dynamic pressure and the forces and moments exerted on the model airplane as it is supported in the tunnel's windstream. The remaining units are associated with receivers of autosyn telemetering devices which indicate the angular settings of the model with respect to the windstream.

Follow-up units applied to the weighing gages determine settings by measuring linear motion to 1/10,000 in. Those applied to autosyn telemetering receivers determine settings by measuring angular motion to 1/100 deg. The follow-up units measure electromechanically with the aid of electronic tubes at a rate of one or two measurements per sec. These measurements are electrically translated into digit representations. The devices receiving digit representations in turn electrically control presentation of digits on lampbanks in the console wall of the control room. Such digit representing devices also electrically control recording operations upon depression of record buttons. Printing and punching of more than 80 columns of figures can be done in less than 3 sec.

Certain data relating to a model plane may remain relatively fixed in value throughout a series of tests. These data may be set up on keyboard units, invented and developed by IBM, and which electrically control the display of numbers on the lampbanks and data recording by the printer and the punch. Each keyboard unit handles a single column of numbers and can be associated with other units to form a multicolumnar structure.

To simulate true flight test conditions, certain models will be equipped with high speed electric motors driving scale-size propellers running at tip speeds equivalent to those of actual flight. For this purpose the tunnel is equipped with a system of high frequency power supply, regulation, and control, together with electric torsion dynamometers and wide range power metering equipment for model motor calibration.

Laboratory facilities include two

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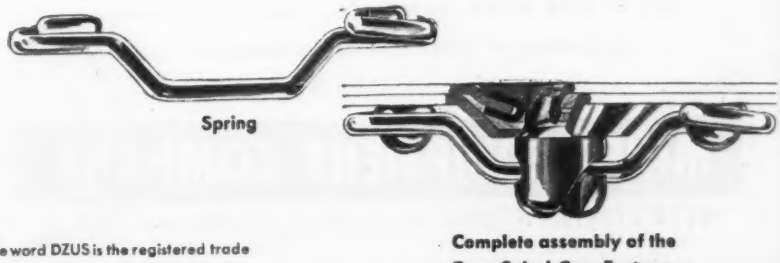

Spring

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model shops, a machine shop, sheet metal and wood shop, and dynamometer room, all on the second floor. A monorail system with two 3-ton hoists connects them all with the loading well where models are unloaded from delivery trucks. By means of an elevator section of rail the hoists may be run directly into the tunnel sphere.

On the ground floor is an engineering design room, blackline print room, photographic dark room, library, stockroom, computing room, conference room, administration office, and director's office.

The tunnel building itself provides space for stock materials, such as steel plates, bars and shapes, pipe and conduit, a welding shop and mechanical maintenance shop, carbon dioxide storage tanks for fire protection, and storage space for miscellaneous hoisting equipment, scaffolds, spare fan blades, and other items.

Facilities and equipment provided for model tests and tunnel calibrations include four 48-in. mercury micromanometers, multiple manometers, Recordak viewer, hinge moment and strain gage reading equipment, etc. For calibration of tunnel flow there are a complete set of survey rakes and probes with pitot tubes and yaw heads to survey the entire working section, a 48 ft. static pressure tube, and a 12 ft. span and 8½ ft. span symmetrical section steel calibration wing.

Aviation and Civilization

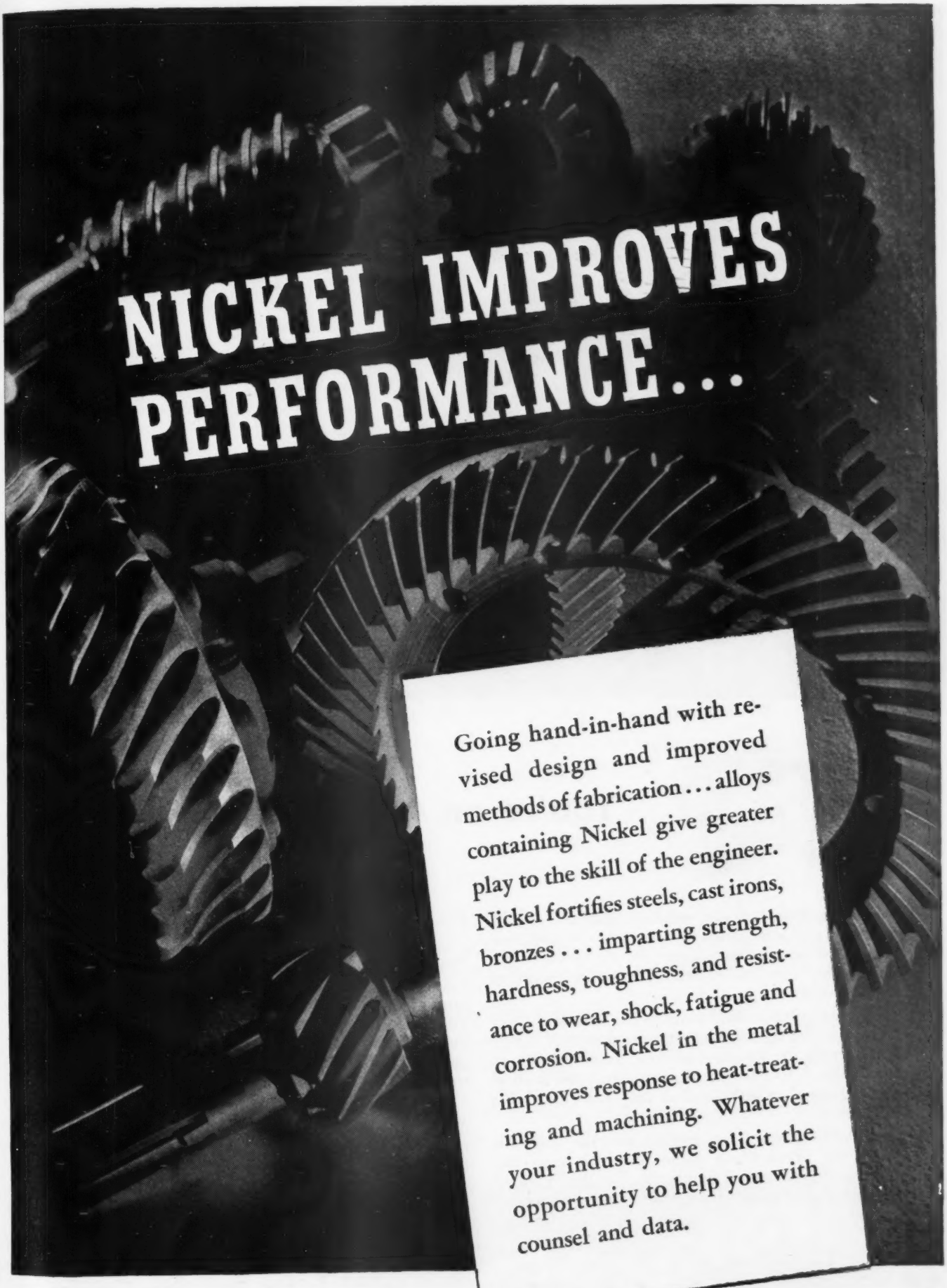
(*Continued from page* 108)

the technical development of aviation will be greater in the next ten years than in the past, and that we must foresee and anticipate this development to a considerable extent in order properly to evaluate the fields of usefulness of aviation in the future.

Let us appraise several fields of human relations to determine where aircraft can contribute positively to progress; to learn the place of aviation in civilization. All of the fields selected here, and there are undoubtedly others, are to some extent interdependent and overlapping, but the samples given should clearly expose the possibilities.

Economic Uses

This science treats of the production, preservation and distribution of wealth. Each of these involves employment, which has prompted me to prepare a forecast to indicate how many jobs aviation should provide in one country, the United States. The attached table, Fig. 3, provides an estimate for a period eight to twelve years after the war. Though even in a



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"You're an Angel...*with wings!*"

Ambulances fly in this war, and their flight brings swift evacuation of the wounded from the areas of front line danger. And because ambulances fly, the wounded are minutes, not days, from the clean sterile mercy of base hospitals.

Flying ambulances lend wings to the skills of doctors and nurses. For doctors and nurses and medical equipment go with the wounded in these hospital wards of the air. The skill of aeronautical engineers and medical science have thus combined to save lives and bring swift mercy.

Fairchild ingenuity, for example, gave the Army Air Forces the "Packet"—a plane in which men and machines can be carried into battle. But the "Packet" is a ship of mercy too, convertible *in a few minutes* to a plane ready to receive the victims of enemy action.

Known to the Army as the C-82, the long-range "Packet" can carry 34 litter cases, four attendants, and medical supplies. Cramped quarters do not hamper nurses ministering to the wounded. An ingenious litter suspension affords ample room for movement. So successful is this strap-suspension device, developed by Fairchild engineers, that it has become standard equipment on all types of planes used as flying hospitals.

Versatile in its applications, the "Packet" can do double duty as a mercy ship. It can carry the wounded from front line evacuation fields over long distances to base hospitals. Returning to the forward areas, it can carry up to *nine tons* of supplies needed at the front lines.

Fairchild Aircraft

Division of Fairchild Engine & Airplane Corporation, Hagerstown, Maryland

THE ARMY NEEDS NURSES

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decade there is a great drop in employment from wartime peaks, there still appears to be a really important contribution to peacetime economy indicated, with more than twelve times the number of persons employed in aviation as were so engaged just prior to the war.

The figures of the table include so-called "grass roots" employment, that is, jobs outside the aircraft industry, such as are involved in mining, fabricating and otherwise preparing the materials used in aircraft construction, supplying tools for aircraft factories and other similar services.

There are a great many direct services which the airplane can render that will find their places in our economic life of the future, and, of course, the list will be supplemented by many others which have not even occurred to us as yet.

First there is so-called taxi service, which may be used extensively in transporting persons and goods from small communities to main stops of trunk lines. Many feel that this form of transportation may be found more economical and therefore more extensively used than small feeder-line services operating on a scheduled basis.

Then there are a great number of charter services for which the airplane is admirably adapted, such as crop dusting and insecticide spraying, aerial planting, spotting services of various natures, such as fire, oil line breakage and fish locations; equipment dropping to furnish needs of persons or communities in isolated locations; and aerial photography, serving a multitude of uses, such as laying out golf courses, estates and communities; and preparation of maps useful in crop planting, soil conservation and flood control.

There are also the obvious services pertaining to aviation itself, such as pilot training and aircraft maintenance and servicing.

One of the most promising uses of the airplane and the one most important from the standpoint of world economics is foreign commerce. When the airplane finds its proper place in this field, and when confidence in the hoped-for world security organization is established, there will be no need for the uneconomic measures of self-sufficiency which are so paramount in the minds of many at this time.

The interdependence of nations in our machine age is becoming more and more apparent. For example, an automobile manufactured in the United States uses materials normally obtained from nine locations in widely scattered sections of the world. Even

Norgren Lubricators protect the vital working parts of all air driven tools and cylinders, and reduce the annual "cut" rust takes from your business. And how that helps get sweet performance!

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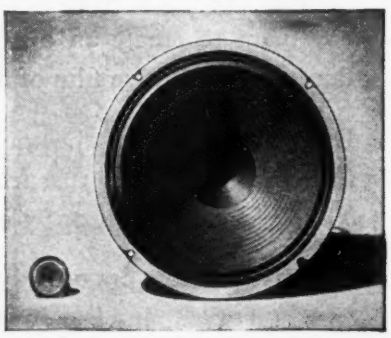

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a telephone requires materials from seven. This all points towards the economic unity of the world.

Obviously, transportation is part of the general economic structure, and the place in which the airplane can play a basic role. Speed of transportation represents a yardstick for the progress of civilization. This speed may, perhaps, in the immediate future allow us to accelerate the tempo of commerce and industry as to catch up economically and socially with the time lost and the material destruction of the war. The tremendous activities of air transport services in the conduct of the war are readily susceptible to transfer to uses essential to rehabilitation and readjustment, involving the transportation of food, medicines and people.

The prospect of such a major contribution is emphasized by the existing trans-Atlantic flying, amounting to a four-engine plane flying one way or the other each 15 min. in the service of the U. S. Air Transport Command alone. Any medium of transportation which finds geographic conditions no barrier must become of major importance.

The factor of speed, which, in addition to independence of ground or water barriers, is the most important contribution the air carrier has to make to transportation, must in itself be reckoned with when forecasting increases in air traffic in the future. It is not appropriate merely to extrapolate past performance in order to determine future achievement.

Whereas within the aviation industry in comparing individual airplanes, a formula of efficiency such as cruising speed multiplied by pay load and divided by some function of cost is appropriate, it is believed that when comparing different media of transportation with different orders of speed in connection with prognostications of future traffic, it is necessary to give further weight to this speed factor possibly by raising the cruising speed term to the second power. The advantages of air transport will engender additional traffic not possible without the presence of the greater time-saving involved when traveling by air. (From the engineering standpoint computations have shown that it is well worth while to increase the cost of a given transport plane by well over $1,000 if by so doing its cruising speed can be increased one mph.)

The increase in air traffic will not, it should be stated, be at the general expense of other means of transportation. The whole tempo will be so raised as to carry along with it added traffic best suited for transportation by rail or steamship, although the relative

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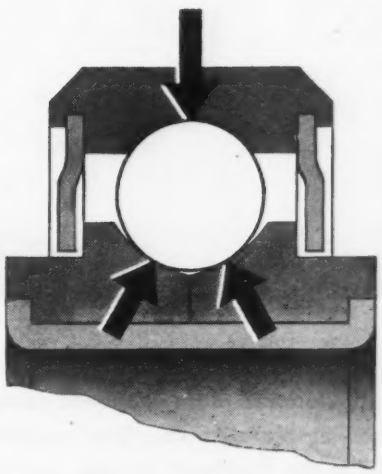

3-point contact reduces impact of shocks and strains and increases the life of the bearing.

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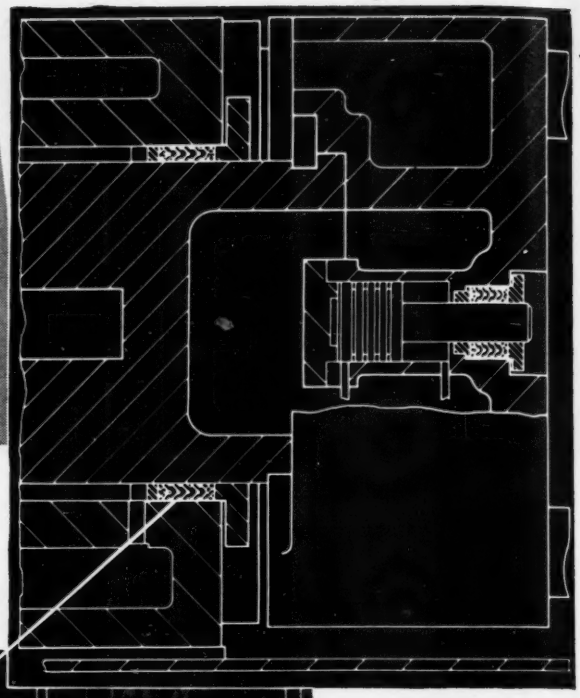

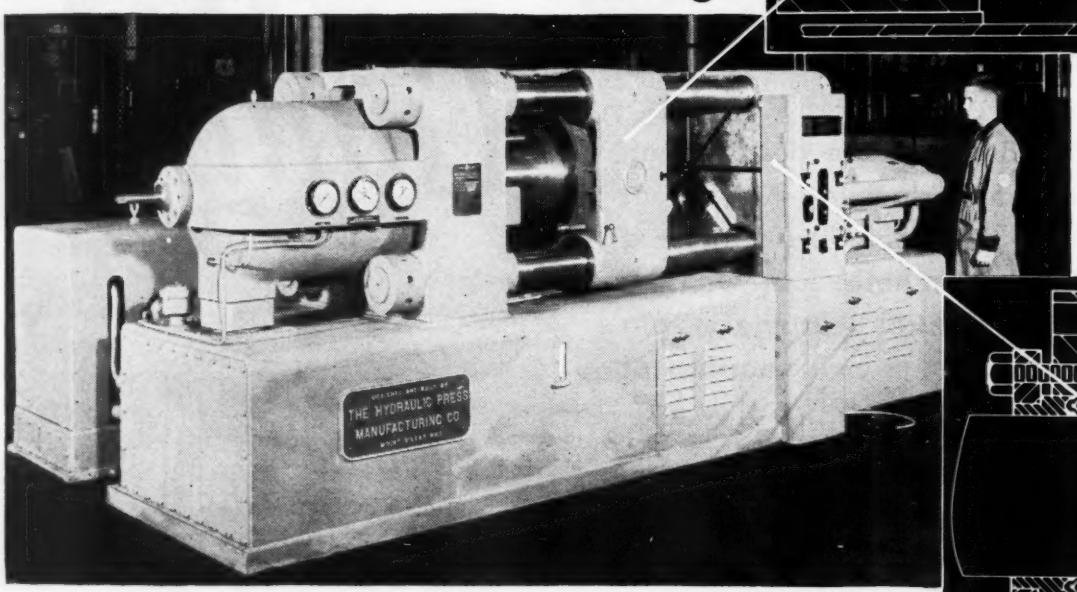

HPM

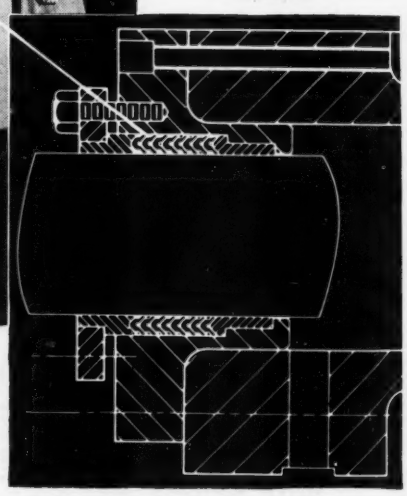

Photo of 400-Ton Die Casting Machine and sketches showing application of Linear "Par" packings to clamp and injection end . . . courtesy of The Hydraulic Press Mfg. Co., Mount Gilead, Ohio.

The H-P-M "All-Hydraulic" die casting machine (illustrated) with standard plunger speeds up to 7200 inches per minute, employs Linear "Par" packings to effectively *seal in* the hydraulic power actuating the high speed, straight-line mold clamp and the very fast injection plungers.

Linear's distinctive design insures a completely automatic packing. As pressure develops the lips expand —and expansion is proportionately reduced when pressure is lowered. Maximum efficiency and uniform pressure maintenance are assured and extreme friction and wear are eliminated.

Made in six compositions, each for a particular service, Linear "Par" packings are specified by hydraulic equipment designers to safeguard hydraulic power from zero to peak pressures—and carefully to control hydraulically operated mechanisms throughout the operating cycle.

Engineering consultation invited . . . sample rings sent upon request. The resources of our testing laboratories and facilities for the complete design of the hydraulic unit itself are available.

LINEAR INCORPORATED

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proportions of types of cargo carried thereon may be substantially altered.

On the accompanying graphs are shown trend curves indicating U. S. air transport statistics for the ten years prior to the war, with extrapolations estimated for the next decade. Although statistics for war years are given, these, obviously, must be discounted, as traffic was abnormally large and equipment greatly reduced.

Revenue passenger load factors which had stabilized at about 60 percent just before the war rose to about 90 percent during the war period and are expected, after the peace is restored, to become reestablished at about 65 percent. Average length of trip for passengers on U. S. domestic airlines before the war was about 400 mi.

Fig. 4 gives passengers carried by U. S. domestic and international air carriers and shows prospect of transporting about 20 million per yr. by 1955. Fig. 5 indicates an increase in passenger miles, 1 billion in 1940 to 12 billion in 1955. An interesting trend of airline passenger miles compared to Pullman is given in Fig. 6. It is estimated that the prewar 10 percent will increase to 50 percent in the next decade. Statistics relating to mail and express are shown in Fig. 7. The anticipated acceleration in express traffic which will equal mail tonnage by 1951 is emphasized as an indication of the decreasing importance by the mail subsidy in air carrier economics.

The passenger fare trend is given in Fig. 8. The present 5c. per mi. tariff should drop to 3c. in ten years. Forecasting cruising speeds is somewhat of a risk because of the tremendous developments anticipated and previously described. Yet a trend curve bringing these speeds to 300 mph. on the average by 1955, as given in Fig. 9, are certainly reasonably sure of attainment and admittedly will be exceeded in many specific instances. On Fig. 10 statistics indicative of improvement in safety are given in terms of passenger fatalities per 100 million passenger mi. flown. This rate at 1 per 100 million is hoped for soon, with losses at less than this number the rule after 1950. Finally, on Fig. 11 the trend in operating efficiency is shown. Improvement is directly proportional to ton-mi. capacity pay load per hp./hr. Substantial and continuous improvement is anticipated.

One may ask, however, "What of the prospect of cost reductions of such magnitude as to bring air travel within the reach of the masses of population?" The trend of statistical information as given above is reassuring in this regard. Whereas for domestic air transport operations in the United States

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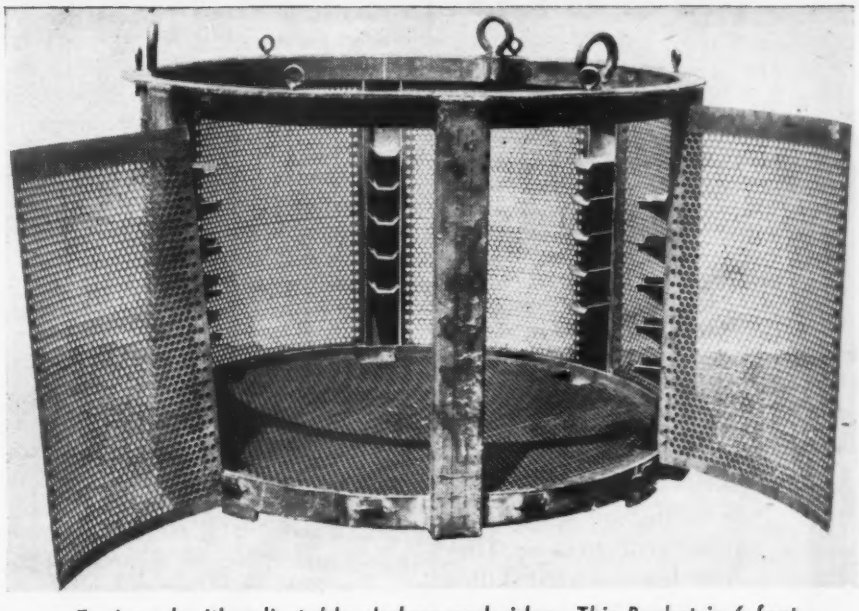

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in the 1920's costs on a capacity load basis were of the order of 50c. per ton mi., these had by the end of the 1930's decreased to 30c. per ton mi., and may, on the basis of civil transport planes now used by the military service, soon after the war drop to figures of the order of 20c. per ton mi. for passenger carrying, and 10c. or 12c. for carriers of cargo only.

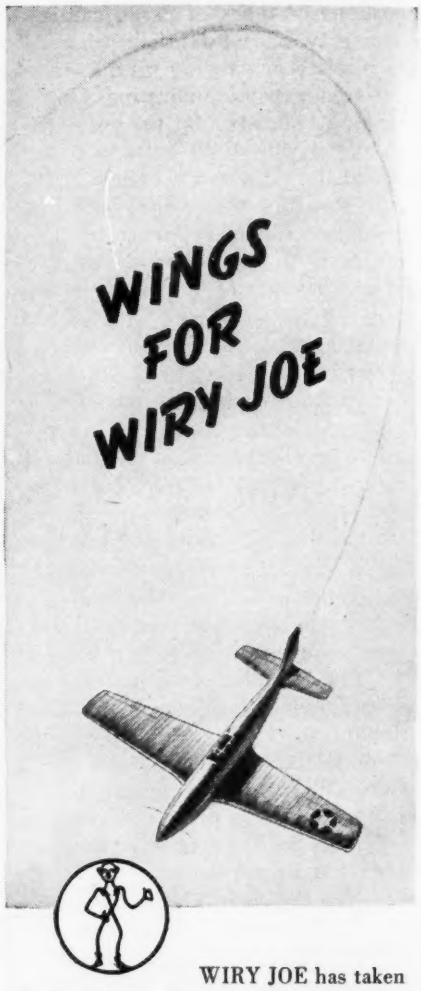
It would therefore appear reasonable and has in fact been estimated, that during the 1950's we may look forward to cost for passenger carriage on a capacity load basis of the order of 15c. and for cargo of 8c. or 9c. per ton mi.

When these figures are translated into fares and tariffs by considering load factors of 65 percent or 70 percent and reasonable profits, it would appear justifiable to expect that during the 1950's passenger air transportation charges of 2½c. per mi. are within the realm of possibility, with express air transportation at rates of the order of 15c. per ton mi. thus comparing favorably with rail travel without taking due account of other very real savings (salary, meals, etc.) attendant to reducing intransit travel time. Certainly passenger travel at 3c. per passenger mi. and express transportation at 20c. per ton mi. is assured.

Forecasting ocean travel rates is difficult unless specific trips are taken into consideration in order that the factor of range so detrimental to cost economy may be accounted for. Recent investigators have indicated the possibility of round trips to England from the United States at figures of the order of $200, or 3c. per passenger mi., and several companies in the United States have actually forecast and published rates not greatly exceeding those figures. I believe these are somewhat optimistic. But even at some increase from this to such a round-trip cost as $300, which is certainly attainable, over-ocean travel may well approach the almost astronomical figures that some authorities have recently predicted.

Although it is probable that air transport will be utilized for the carrying of passengers, mail and express for the most part, there are possibilities for carrying freight, although probably not commodities of a bulk nature, i.e. those of low value per ton. The greatest potential here lies in supplying the needs of backward and undeveloped regions where other means of transportation may take weeks or months as compared to hours when carried by air.

It is anticipated that express carrying will advance by leaps and bounds after the war. Whereas at present the proportion of load carried by the domestic airlines of the United States



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is 75 percent for passengers, 17 percent for mail and 6 percent for express (with 2 percent for other uses), it is reckoned that the percentage for express will increase to a point where it will approximate that devoted to mail, even though the latter should itself be substantially increased by virtue of the probable eventual removal of any mail tariff surcharge.

For over-ocean traffic the percentage devoted to mail before the war considerably exceeded that for passengers. It is believed possible that this disparity may lessen after the war.

Consideration should be given to the factor of population mobility, and I will close this section with a brief reference to the private plane or the personal aircraft. In evaluating the effect which such planes may have on city planning, full account must be taken of the tremendous change in our way of life which will be occasioned by the roof-top landings to which reference is frequently made, though its significance is seldom fully appreciated.

If the helicopter should come into its own, as many expect, so that real masses of people could be moved to their places of business from their residences by air, the situation of road congestion would be so altered as substantially to affect the whole architectural arrangement of our cities. Also the possibilities of locating residence sections farther from metropolitan business centers open vast vistas for the city planners. Recreational possibilities will be greatly enhanced by this greater mobility.

Mexico Girds for Air

(*Continued from page* 187)

of his country, likes to travel, and can be seen on all types of transportation, from airplanes on down, moving from one end of the Republic to the other, either for work or to visit relatives. He is seen, on trains or buses, carrying his whole household with him, including not only innumerable children but also fowl and an occasional pig or two, and with bunches of bananas, fresh and dried meat, fish, and other victuals in the baggage rack. He frankly admits that the airplane intrigues him, hence he'll fly when possible, if he has the money available, in which case he puts on his best Sunday clothes and is quite obviously thoroughly at home and enjoying himself.

However, this everyday Mexican has heard of various accidents to overloaded single-engined airplanes, and he is beginning to insist on larger, modern equipment with two or more engines. He also wants better air-

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ports, additional safety facilities, and more convenient connections. Even so, he has no objection to getting out to the airport at 5 A. M. to be able to do his business in one day, because in most towns everything closes for the day by 1 P. M.

The all-day train connection, always leaving early in the morning, necessitates his allowing three days, while by air he might be able to get home in one-and-a-half or even one day. The Civil Aviation Department, in its drive for modernization is therefore doing exactly what the average traveler in Mexico wants, and the obviously higher cost for the operator will be offset by increased travel and subsequent higher income.

The situation outlined above affects not only passenger transportation in Mexico, but also the shipment of goods by air. Mexico is a good example of a country where cargo operations, even at rates comparable to U. S. air express, have a greater immediate chance of success than in the United States where excellent rail connections are so common.

On Mexican railroads, express and freight rates have increased many hundred percent over the past four or five years, and freight cars are too few to carry the merchandise awaiting shipment. In addition, as can be seen from the accompanying map of the railroads, the routes are circuitous. Freight to the important Pacific port of Mazatlan takes an average of four weeks from Mexico City, while the railroad passenger can make the same trip in 34 hr. In addition, the railroads have the bad habit of losing boxcars for weeks, after which they suddenly turn up in some out of the way spot.

Such a condition makes air cargo and air express attractive to the Mexican businessman, and even at the relatively high rates now in force (running as high as $100 per ton-mile in isolated sections of the Republic) shipments by air are of considerable volume. Unfortunately, the only exact figures available are for shipments out of the Federal Airport at Mexico City. These show that in Dec. 1944 loads averaged 940 lb. per flight to Merida, 430 lb. to Los Angeles and over 500 lb. to Guatemala. Totals of loads carried during that month were, respectively, 139,000, 52,000, and 63,000 lb.

Another factor which affects all travel and shipment by air is, of course, the isolation of many important parts of the country, often only reachable by airplane. Among these areas are the Yucatan Peninsula and virtually the entire southeastern section of the Republic—both regions which are becoming more and more important in

Mexico's general business economy.

In such sections virtually all living necessities are transported by air—from food and drinking water to laundry for the more wealthy inhabitants. Even for certain fruits and vegetables the air cargo possibilities in such areas are excellent, despite the rates; for lack of surface transportation has yoked many of the large producers with losses as high as 80% of their entire crop in a single year, while by air much of it could be distributed. Also, costs of such items in sections where shipping facilities are few and far between are high enough to make their air transport feasible at 40 or 50 U. S. cents per ton-mile still enabling sale of these superior fresh products at prices from 25 to 30% below those shipped by other means.

Difficulties, mainly in problems of terrain, indicate that real improvement on surface transportation is many years off, hence it is the consensus of Mexican experts that the upswing in internal air traffic will continue. However, these observers feel that the time has come to put a halt to the promiscuous issuance of new permits. They believe that the period of stabilization of the Mexican air transport picture has just started.

Restrictions on foreign capital and control have become much stricter, an effort being made to halt the inflow of foreign investors who are looking for temporary investments during the clean-up period in Europe. Mexico thus seeks to prevent disastrous blows to its economy such as if many millions of *pesos* were suddenly withdrawn. These restrictions are naturally also affecting new airline enterprises and, as stated before, requirements for the operators themselves have become conducive to safer and sounder airline operations.

As matters stand now, there is a decided competition shaping up. On one side is Pan American Airways (including its interests in CMA and Aeronaves, with some 14,000 mi. of important routes in all) and on the other such operators as LAMSA, Aero-Transportes, Braniff, and Azteca (with among them more than 21,000 mi. of routes).

It would seem that the latter lines—mostly U. S. controlled, as stated earlier—would need to institute some cooperative plan merely to come out even in the battle with Pan American, whose strong status is well known. On the other hand, that Pan American is becoming restive about the unquestionably powerful newcomers appears indicated by its sale of approximately a one-third interest in CMA to a group of important figures in Mexico. This move might be interpreted as a means

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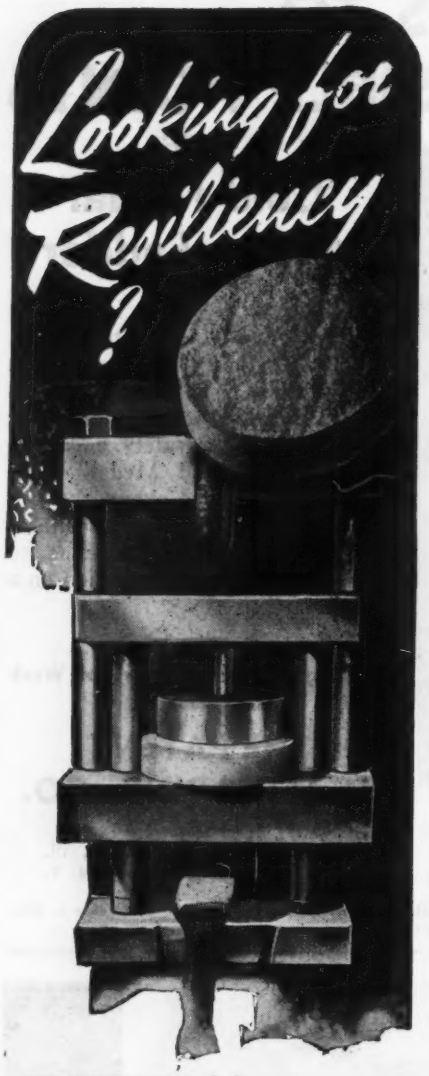

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In the final analysis, however, little more than a practical neutrality is to be expected from Government circles, where it is felt that this competition of interests will ultimately improve air services in the land, to the benefit of every Mexican concerned.

Somewhat on the outskirts of this line-up stand three other operators, Panini, TAMSA, and Communicaciones Aereas de Veracruz. It is noted that both Panini and TAMSA have for some time been for sale to the highest bidder. TAMSA is considered to have more to offer than Panini, including a good air cargo route along the Gulf Coast from Merida to Matamoras just south of Brownsville. Communicaciones Aereas de Veracruz, which recently absorbed another local system, is known to be talking business with TACA, and the possibility of an outright sale is looming.

Between them, therefore, the eight companies discussed above (counting Pan American and satellites as a single unit) control nearly 43,000 of Mexico's total of 52,700 mi. of certificated air routes. After deducting the 3,400 mi. operated by such lines as American, Braniff, and TACA there are but 6,600 mi. of routes left, to be divided between about 20 operators. Little wonder therefore that it is generally believed that Mexico will eventually have five or six foreign airlines operating over its territory, and not more than ten domestic operators.

In a situation similiar to that in which the United States found itself 15 yr. ago, Mexico stands at the aerial crossways, waiting with more than passive interest for the really first class aerial passenger and cargo operations which it needs to fully develop its resources commensurate with its broad potentials.

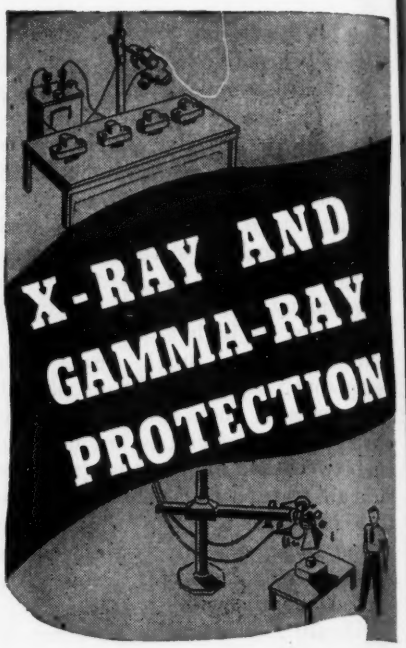
Book Reviews

(*Continued from page 229*)

from its discovery in China centuries ago to modern wartime developments in robot, bazooka, and jet-propelled plane. Treatment envisages various key possibilities of rocket power in future.

INDUSTRIAL ORGANIZATION AND MANAGEMENT, by Lawrence L. Bethel, Franklin S. Atwater, George H. E. Smith, and Harvey A. Stackman, Jr. McGraw-Hill Book Co., N. Y. C. 798 pages, text, illustrations, graphs. $4.50. This work is designed to prepare students for advanced work in methods, cost, industrial relations, budgeting, production control, marketing, office management, etc. Volume is divided into four principle sections: American Industry, Organization of Industrial Enterprises, Operation of Enterprises, and Coordination of Enterprises.

THE AIRMAN'S ALMANAC, 1945. Edited by Francis Walton. Farrar & Rinehart, New York City. 512 pages, text. $1.00. This handy book is described as containing "1001 facts on world aviation." Rules, routes, records, operations, airports, flyers,



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planes, engines, history, law, diet, aids, medicine, finance, avigation, etc., are treated. For several years, Editor Walton handled aviation news for the New York Herald-Tribune.

MANAGEMENT AT THE BARGAINING TABLE, by Lee H. Hill and Charles R. Hook, Jr. McGraw-Hill Book Co., New York City. 300 pages, text, bibliography. $3.00.

Treatment of collective bargaining, giving viewpoints for management and its representatives on principles involved, knowledge of agreements, and steps in negotiating them.

Review of Patents

(*Continued from page 229*)

signed for method to fixedly secure transverse member in a predetermined central horizontal position, mount panels in substantially vertical position on each side thereof and spaced therefrom, make service connections, and translate panels into engagement with transverse member, while preserving initial horizontal alignment and making permanent structural connections.—2,374,894, filed June 16, '43, pat. May 1, '45, W. F. Ploch and G. E. Scarlett, assignors to Ford Motor Co.

Propeller Pitch Control is intended to be effective in turning blades beyond normal pitch range arc by development of higher fluid pressure than that of engine-driven pump, the higher pressure being produced by fluid compressor or pump driven through independent means.—2,375,028, filed Sept. 7, '39, pat. May 1, '45, R. M. Nardone, assignor to Bendix Aviation Corp.

Airplane designed to utilize all air from slipstream for lift and also to have maximum lateral stability, embodies fuselage having forward end in form of concave tunnel on underside, the laterals of fuselage rear being extended in winglike form. —2,375,265, filed Feb. 8, '41, pat. May 8, '45, J. Wagner.

Wood or Plastic Propeller Blades are adapted for use with variable pitch control mechanism, by utilizing metal sleeve with internal and external threads for screwing into a cylindrical groove in blade to effect connection to control mechanism. —2,375,326, filed July 18, '42, pat. May 8, '45, J. R. Roché and F. A. Roché.

Lift-Increasing Means for takeoff or steady flight embodies wings with detachable portions which can be discarded when aircraft is airborne. Each wing is provided with a detachable tip secured by hook attachments with provision for effecting release under the pilot's control.—2,375,423, filed Jan. 23, '43, pat. May 8, '45, M. J. O. Lobelle, assignor to R. Malcom Ltd.

Control System for rotary wing craft is designed to provide rapid pitch increase for propulsive airscrew, following rotor acceleration period, so as to establish translational flight speed at rapid rate and thereby avoid loss of altitude at end of direct takeoff maneuver.—2,375,465, filed June 19, '41, pat. May 8, '45, H. S. Campbell, assignor to Autogiro Co. of America.

Slotted Aileron and Flap operating mechanism, housed within wing profile to offer little resistance to airstream, projects movable surface rearwardly and downwardly to create a slot of desired width and shape.—2,375,610, filed June 4, '41, pat. May 8, '45, J. R. Allen, assignor to Consolidated Vultee Aircraft Corp.

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Recently announced by U. S. Patent Office is inauguration of a new service intended to bring to the attention of the public those patented inventions under which owners are willing to grant licenses. A *Register of Patents Available for Licensing* will be maintained in the Patent Office, and patents recorded on the register will be available for inspection in Washington, D. C. Lists of the patents will be published in the *Official Gazette of the Patent Office.*

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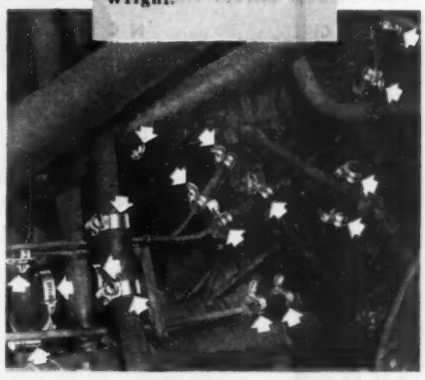

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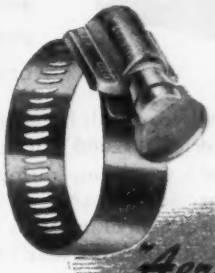

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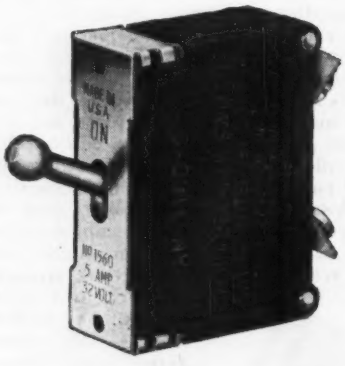

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